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MOTTO: "And another came, saying, Lord, behold, here is thy pound, which I have kept laid up in a napkin: for I feared thee, because thou art an austere man."

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TORPEDOES IN EXERCISE AND BATTLE.

By J. M. ELLICOTT, Lieutenant, U. S. Navy.

Nearly all ships of our navy are now equipped with automobile torpedoes, while only a small percentage of our officers and men are as yet instructed in their use. In many cases, therefore, these weapons must be assembled, adjusted and fired by inexperienced hands or left as idle material in the hold. Their large cost, their vessel-like structure and their occasional and seemingly inexplicable disappearance in target practice, naturally make officers chary about using them. Even the most experienced torpedoist learns something new about their behavior at almost every exercise run.

If we are ever to progress with this weapon, however, it must not be regarded as a costly, erratic and fragile vessel, but as a projectile subject to expenditure in target practice like a common shell. From our battle-ships we shall throw fourteen thousand dollars worth of ammunition annually into the sea, and we regard the experience to be gained a full repayment, yet we know

far better how to use the gun than we do how to use the torpedo. If we exercise as often with torpedoes as we do with powder and shell there might be one or two torpedoes lost from a ship in a year. The Whitehead costs, exclusive of accessories, about $2000 and the Howell about $1500, so that an expenditure of $3500 a year, or one-fourth a battle-ship's expenditure of ammunition, is a reasonable estimate for torpedo practice. The fact that the torpedo is a recoverable projectile should make its use even more frequent than the use of great-gun ammunition. I would advocate torpedo target practice once a week, either stationary or moving, in port or at sea, and that, if possible, every torpedo in the ship be used at least once a month. Each has its individual eccentricities which can only be learned by using it. Each will behave differently under different conditions, and its behavior should be learned in smooth water and in rough water, in salt water and in fresh water, when full-charged and when under-charged, with air leaks and without them, and at various angles of train and depression.

After a careful study of foreign automobile torpedoes before the United States commenced their manufacture, and after a subsequent course of instruction at the U. S. Torpedo School, I found myself upon one of our modern cruisers equipped with above-water, broadside-pivot launching tubes for Whitehead torpedoes and a fixed bow tube for Howell torpedoes. She carried U. S. Navy Howells and Whiteheads, Mark I., and a Brotherhood air compressor with its separator, but no accumulator. The bow tube, as the ship was customarily trimmed, had 45′ elevation instead of the customary 3° depression. When I prepared to exercise with this outfit the torpedoes were boxed in sections in the hold, their brackets and trolleys were not installed and the tubes and air compressor had never been used. As torpedo officers may frequently have to start from this point, I think it well to suggest in detail a method of procedure, endeavoring not to duplicate but to supplement the very excellent books now being issued by the Navy Department for general guidance.

Assembling the Whitehead.

A ship will receive her torpedoes boxed in four sections, viz: the war head, the exercise head, the middle section and the after body. The sections will be found in neatly fitting chocks inside

the boxes, and these chocks can be lifted out and used as rests in assembling. The sections should be carefully examined inside with lighted tapers before assembling, for some movable parts may be tied with twine, or foreign substances may have fallen in. Care should be taken, however, not to bring lighted tapers in contact with springs, as it might affect their elasticity.

It is also important to make sure, by corresponding numbers on the parts of the torpedo, that you are putting together sections of the same weapon. When I assembled my first Whitehead I relied upon the numbers on the outside of the packing cases, and inadvertently attached the after body of one torpedo to the air flask of another. Some excellent runs were made before my mistake was discovered. The card adjustments for the air flask number were used without change, except for the vertical vanes, which had to be set at -8 instead of $+2$.

Before assembling the Whitehead make the following tests:

1. Remove the charging check valve; open the stop valve; sling the air flask upside down and with its forward end 60° upward, so that if any water is inside it may drain out.

2. Turn the flask right side up and level; replace the charging check valve; tilt the flask up and down, using the pendulum level, and note at what angle each way the horizontal rudder rod begins to move through the bulkhead. It should not be far from 3°, but if it is widely different, the immersion mechanism must be removed and the equalizing springs of the pendulum adjusted. The so-called pendulum level is a sluggish instrument and must be tilted in use so that the bob will swing free from the graduated surface.

3. Take off the immersion chamber bulkhead and examine its gasket. If it is defective put in a new one. At the same time make an examination of the chamber to see that it is clean and dry. Set up the bulkhead nuts equally and tight in closing this chamber.

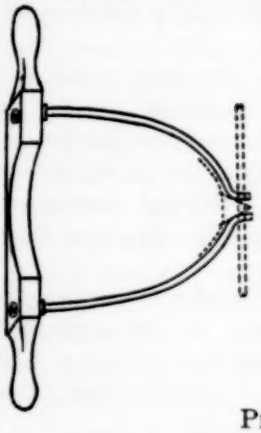
4. Place a push-balance (one will be found in Howell Accessory Box No. 1) against the hydrostatic piston; set the depth index at 5 feet and push on the balance until the rudder rods move. Note the registered pressure, which should be 29 lbs. for Whiteheads now in service. Make a record of the amount of difference if it is appreciable.

5. Remove the engine bulkhead; examine the gasket and re-

new it if necessary; examine the interior of the after body; replace the engine bulkhead and set up all the nuts alike and tight.

The after body may now be connected up to the air flask. While doing so, the ratchet bar of the locking gear must be kept pressed back until the ratchet wheel spindle passes under it, and care must be taken that the end of the rudder rod and of the steering engine valve stem do not butt against each other. After setting up the joint-screws place the screws in the valve stem joint and the air pipe flange. Great care must be taken in connecting up the valve group. The screw connecting it to the engine casting should be left slack until those in the flanges are set up, and all four of the flange screws should be set up alike, a little at a time on each until all are quite tight. Inequalities in this work will be a sure cause of air leaks.

The exercise head is very awkward to handle, especially when filled. To fill it, remove the nose and rest the head, small end down. Fill with clean, fresh water until it is above the bulkhead flange, and set up the bulkhead nuts with the bulkhead awash, so as to insure no air space inside. The wash of water in a partly filled head will seriously affect a torpedo's course.



A rack for transporting the filled head can be made on board ship, as shown in the sketch. Such a rack is used at the Torpedo Station and on board the cruiser I have mentioned. The head once filled can remain so for any desired length of time, but it would be a good precaution to refill it once a quarter, or oftener if it seems to leak, making sure that the interior is free from rust.

Preparing the Tube.

A new tube must be carefully examined before attempting to fire a torpedo from it. The following procedure is suggested:

1. Measure the drop of the tripping latch inside the tube and ascertain if it is sufficient to trip the starting lever of the torpedo. A lump was found on the surface of the tripping latch slotway in one of the tubes under my care, which restrained the latch half an inch short of its full drop. It was an excrescence in the casting and had to be filed off.

2. Note, when the firing lever is hooked up, if the stop pin projects into the guide stud groove.

3. See if the tube door closes tightly. If it seems loose when latched, slack off the tap screws in the catch and drive down the wedge.

4. Thoroughly lubricate the elevating and training gear, and work both gears to their limits until they can be operated with but little effort. Note, by looking through the tube at extreme train each way, if the torpedo upon discharge will clear the sides of the port. Note the same for extreme depression and 5° elevation. See that the port shutter when opened swings entirely clear of the port.

5. Set up the compression band nut until the band is plainly visible inside the walls of the tube all around. Lubricate the tube thoroughly with vaseline, enter the torpedo and shove it home until it jambs. Keep two men steadily shoving on the torpedo with the rammer and slack off the compression band nut until they can just push the torpedo home.

Testing the Charging Arrangements.

The air compressor can be tested by placing a blank flange in the charging pipe union at the separator and running the pump until the gauge registers full pressure. When this pressure is attained, slack off the safety valve until air just begins to escape from it. Blow off the air from the separator through the drain cock at its bottom.

Whitehead torpedoes should be so stowed in their racks that their port sides would be inboard and accessible. There should be two charging pipes, so that the torpedoes can be charged either in their racks or in the tube, but if only one is furnished, bend it for charging the torpedo in the tube. Charging pipes, being of copper, may be bent cold by hand to the most advantageous shape for charging, but if a very sharp bend must be made the pipe should be first filled with resin.

Testing the Regulators.

Charge the torpedo to about 800 lbs. pressure; fill the engine and valve group oil pots; remove the engine room door and proceed as follows:

1. Secure the lock of the propellers; compress the regulator spring two turns; open the stop valve one-half turn; lift the starting lever and, with a lighted taper, examine for air leaks (a) around the follower ring over the reducing valve, (b) at the joint between the valve group and engine, (c) around the stem of the controlling valve, (d) around the engine valve chest bonnets and cylinder heads, (e) around the unions of the steering engine pipes, (f) around the crank case cover, (g) around the steering engine stuffing boxes. This examination must be made rapidly and the starting lever closed when it is over. Set up with the proper tool when a leak is found.

2. Lay the horizontal rudder in the plane of the axis of the torpedo by aligning it with a straight edge along the horizontal tail frame; set the rudder index to 0° of the scale on the vertical frame; throw back the starting lever and note if the rudder drops down 1½ to 2 marks on the scale. Move the controlling valve of the steering engine back and forth and see if the rudder responds with a throw of 4 marks down and 3 to 3½ up. If it has a different set and throw, adjust by the valve star until the above is attained. A set screw in the valve star must be slacked before the latter can be operated, and this should be set up again after adjustments are made.

Place the testing lever (tool 36) on the hydrostatic piston and press it forward, noting if there is ¼ to ½ mark less up rudder than down. The full throw of the horizontal rudder may be increased or decreased by unscrewing the rudder rod from the bell-crank at the tail and giving the rod one or more full turns. Each turn alters the throw of the rudder ¾ mark. In the Mark I. torpedoes the tail has to be removed to make this adjustment.

When adjusting the rudder, only lift the starting lever long enough to verify each adjustment, so as to expend as little air as possible.

3. Lock the horizontal rudder with two teeth of the ratchet bar engaged. Note if it is locked at the inclination required by the adjustment card. If not, turn the locking star until this inclination is indicated by the rudder index. The locking star pawls twelve times in one revolution, and six pawls change the inclination of the rudder one mark. Set the distance gear sector two teeth. Slightly raise the starting lever and let the engine revolve slowly until the distance gear stops it. See then if the ratchet bar has unlocked the rudder.

4. See that the sinking valve (if any) seats securely in its bulkhead.

5. Replace the engine room door, being careful to see that the water tripper bell-crank stud enters the jaws of the retarding lever; also that the tripper operates freely.

Preparations for Firing.

These will be found in the Drill Book, but the following precautions are suggested by experience:

Drain Holes and Plugs.—There are two in the immersion chamber and two in the after body. Both in each compartment must be removed to insure drainage. New drain plugs always have burrs in the wake of the slots in their heads, which must be removed to insure complete closure. The drain plug for the transportation screw hole is kept in the head of the transportation screw, but all drain plugs are alike and interchangeable. Drains should be left open while torpedoes are in the racks.

Oil Pots and Oil Ways should be filled before every run. The consumption of oil is very great.

When using registers a washer must be placed under their flanges to insure a water-tight joint. When a register is used, load the torpedo home very gently if the port is closed, for the register fan has been known to take against the port shutter and get bruised. In such a case the shutter must be started in order to complete the loading without injury. No scale is furnished with the depth register card, so that the curve traced only indicates relatively the immersion during the run. If the immersion is co-ordinated by nets, however, a scale can be constructed. The torpedo officer on board ship should do this if the opportunity is presented. The rolling register need only be used when improper trim is suspected of being the cause of lateral deviation.

Precautions in charging.—The portable pressure gauge should be used to ascertain if any air is in the flask before charging. If there is already some pressure, the stop valve must be closed, the charging pipe connected and the compressor run until the pressure in the charging pipe equals that held in the flask. Then open the stop valve and finish charging. If charging from accumulators this precaution is unnecessary.

When the flask is charged the stop valve should be closed and the air backed out of the charging pipe before removing the

wing nut. This can be done by lifting the starting lever, keeping the propellers locked, or by opening the drain cock under the separator, or by both methods at once. If charging from accumulators, close accumulator stop valve as well as flask stop valve before draining off.

Should full pressure be obtained abnormally soon when charging, the stop valve is probably only partially open or has been inadvertently left closed.

Depth Index.—As soon as possible in practice it should be learned at what actual depth each torpedo runs for a given setting of the index. A small correction to be applied to the index may thus be discovered and should be recorded on the adjustment card together with the density of the water in which it was obtained. The depth index is marked for water of specific gravity 1.026. In fresh water the torpedo should run nearly one third of a foot deeper than the register calls for. Be sure to set up the jamb nut after setting the depth index, for if it is loose the immersion chamber may be flooded during the run.

When *the distance gear* is set by the card the torpedo may exceed the corresponding range as much as 100 yards. This must be kept in mind when looking for a clear range in confined waters. If the point of broach is co-ordinated several times, a closer approximation to the proper distance gear adjustment may be made than that given by the card.

The regulator spring of the reducing valve has adjustments recorded on the adjustment card for flask charged to full pressure. When there is a lower flask pressure the spring must be under smaller compression to maintain uniform speed, and uniformity in speed is very essential to a straight run. The proper allowance for different flask pressures can be obtained, as will be shown later.

If the vertical vanes should have *plus* adjustment the starboard vane is set; if *minus*, the port vane is set, the other vane remaining at zero. If the torpedo needs more helm than the vanes will give (8 marks), file the proper slotway longer. Resort to this, however, only after diligent search for the cause of deviation.

The water tripper has sometimes failed to operate, but the failures have been so infrequent that it may be used with confidence in exercise. Its disuse causes no immediate injury, but probably shortens the life of an engine. In a battle run it is best not to use it.

Be sure that the *firing lever* is hooked up before ramming home. Listen for the snap of the *tripping latch* over the guide stud, and if it is not heard, sound with the latch lever to see if the latch is resting on the torpedo. When the torpedo is home work the firing lever up and down to see that the stop pin is not jammed against the guide stud, but do not do this with the port open and ship rolling, without keeping hold of the torpedo by the tail line. Before closing the tube door turn the propellers until the notch on the propeller shaft is at five o'clock (↘) to insure the engine being off the center.

Torpedo Target Practice.

Suggestions as to the choice of a range will be found in the back of the Drill Book.

A distance line 200 feet long, stretched between two anchored buoys, makes a suitable target. Every 25 feet along the line should be marked by floats and flags, placing a red flag at the center, white flags next each way, then blue flags, then white again. An observer in a boat lying near the line could then easily tell under which space the torpedo passed. Every ship, however, should be furnished with a net 200′ by 10′, with meshes about 4″ square, fitted with corks to float it and leads to keep it vertical, to be used as a target when making the annual verification of torpedo adjustments.

There should be no hesitation whatever about conducting torpedo practice in favorable weather at sea, provided that torpedoes are used which have proven their good behavior in harbor practice. Commanders should not be condemned when torpedoes are occasionally lost in this way, but should be encouraged to exercise with them under sea conditions. An empty pork barrel is a sufficient sea target, with a whale boat near at hand to recover the torpedo. Such practice should be "moving" at standard battle speed, and it could be plotted from the following observations:

An observer abreast the tube will note by a Pelorus the azimuth of the target from the ship's course at the instant of firing, and again at the instant of broach. A second observer at the same place will observe with a T the angle between the target and the torpedo when it broaches.

The number of revolutions of the ship's engines from the instant of firing to the instant of torpedo broaching will be noted, from which to obtain the distance run by the ship, for it is wanted with accuracy. This will give the base line *AB* in the diagram when plotted to scale, and from the target azimuths taken at *A* and *B* the position of the target *C* can be plotted. The T-angle taken at *B* gives the line *BP*. With *A* as a center and a radius equal to the run for which the torpedo was set, with its correction if known, find *P*. Join *AP* and draw *CD* perpendicular to *AC*. *CD*, when measured, will give the lateral deviation of the torpedo. Its depth register will indicate its immersion.

Instead of observing target azimuths at *A* and *B*, the distance of the target from these two points might be determined by Buckner's method, and its position plotted by intersecting arcs.

Recovery after Firing.

General instructions will be found at the back of the Drill Book. To use the nose line properly, pass the plug through the hole in the exercise nose and take two half hitches with the bight of the line around the end of the plug. If a register is in the head, the torpedo should be towed home tail foremost by the tail line taken around the after body just forward of the tail frames and hooked to its own part. If the tail line is hooked in the propeller lock and the torpedo is towed in a seaway, there is danger of jerking the lock off the propellers.

A torpedo is in greatest danger of injury while being hoisted on board and struck below. There should be no necessity for doing this. A small davit could be fitted to the ship above the torpedo port in such a position that the torpedo could be hoisted clear of the water, then the tail line passed in through the tube and the torpedo pointed tail in and hauled through. The port shutters now fitted to open upwards would be a hindrance to this, but they are clumsy things anyhow and, I believe, could better be replaced by sliding shutters or double shutters hinged at their sides. Even with the present shutter, a portable bracket having

a guide stud groove could be fitted in the mouth of the tube after firing, which would project a little beyond the outer edge of the lifted shutter, or the latter could be fitted to swing up flat against the side or to be easily unshipped during torpedo practice with the aid of the davit described.

Density of the Water.

The weight of the present U. S. Navy Whitehead torpedo ready for an exercise run is 836 lbs. Its displacement when submerged in sea water (specific gravity 1.026) is 838 lbs. Its displacement in fresh water is, therefore, 817 lbs. If the density of the water is 1.023 or less, the torpedo when first discharged is not buoyant. If by any chance the torpedo then fails to run it will sink, and in absolutely fresh water it will go down with the very appreciable weight of 19 lbs. Consequently, when discharged in our bays and rivers or in the lakes, a fully-charged torpedo which fails to run is going to sink at once and be temporarily, if not altogether, lost. The weight of air in the flask, however, at 1350 lbs. pressure, is 50 lbs., so that if the flask is not charged to full pressure it will have additional buoyancy. Until a ship's torpedo installment has been sufficiently tested to make the failure of a torpedo to run after discharge extremely improbable, the density of the water at the range should be obtained before practice, and the air flasks under-charged in accordance with the following table:

Table I.

Density of the Water.	Flask pressure which will insure 2-lbs. buoyancy.
1.0260	1350 lbs.
1.0235	1300 lbs.
1.0210	1250 lbs.
1.0185	1200 lbs.
1.0160	1150 lbs.
1.0135	1100 lbs.
1.0110	1050 lbs.
1.0085	1000 lbs.
1.0060	950 lbs.

Below a density of 1.006, which is that of the water in the upper Chesapeake and Delaware Bays, the flask pressure would have to be carried too low for a working pressure in order to insure initial buoyancy, so the precaution then becomes impossible and

a return to full pressure may as well be made. In water absolutely fresh a loss of flask pressure of 570 lbs. insures buoyancy with our Mark I. Whitehead, and as more than this is always lost in a 400-yd. run, there is no danger of a fully-charged Whitehead lacking buoyancy at the end of a run unless it leaks.

The density of the water seems also to affect the range. In water nearly fresh the torpedo will considerably overrun the distance for which it is set. It is important to keep this in mind if there is not much clear water beyond the range.

When the initial flask pressure is less than 1350 lbs., the adjustment of the regulator spring per card will be at too great a compression to give uniform engine pressure throughout the run, and the torpedo will be slowing down toward the end of the range. Uniformity of speed is very essential to a straight course, so the proper adjustment of the regulator spring for a series of initial pressures from 1350 to 1000 pounds should be obtained and tabulated. With this end in view I made the following experiments with Whitehead No. —:

A valve chest bonnet was removed and a nipple screwed in its place, on which was screwed the portable pressure gauge.

The air flask was charged to 1200 lbs., the propellers locked, the regulator screwed down one turn at a time, and between each turn the starting lever was thrown back and the pressure at the engine noted. This was done several times both while compressing and releasing the regulator spring, with practically the same results, which are shown in the following selected table:

TABLE II.

Turns of Regulator.	Flask Pressure.	Engine Pressure.
13	1200 lbs.	950 lbs.
12	1175 "	950 "
11	1125 "	950 "
10	1100 "	950 "
9	1050 "	900 "
8	1025 "	850 "
7	1000 "	750 "
6	975 "	650 "
5	960 "	550 "
4	950 "	450 "
3	940 "	350 "
2	930 "	250 "
1	920 "	150 "
0	910 "	000 "

Six series of tests were made, beginning with different turns of the regulator. It is probable that the statical engine pressures recorded are in excess of the pressures when the torpedo is running. The results show that ten turns of the regulator give the maximum engine pressure in this torpedo, and that, when wide open, the reducing valve cannot admit air to a greater pressure than 950 lbs., while from eight turns down to one turn each turn of the regulator changes the engine pressure 100 lbs.

An examination of a large number of general practice records indicates that the loss of pressure in the air flask is 650 lbs. for 400 yds., and that this seems to be nearly independent of the initial pressure. Therefore, by subtracting 650 lbs. from the initial flask pressure we will get the final pressure after a 400-yd. run, and this final pressure will evidently be the maximum engine pressure which can be carried throughout the run. Taking it into the column of engine pressure given above, the corresponding number of turns of the regulator will be found.

Tables 1 and 2 may be combined for any one torpedo and may be found approximately applicable to all Whiteheads of the same mark.

TABLE III.

Density of the water.	Charge Flask to:	Corresponding Engine Pressure.	Set Regulator:
1.0260	1350 lbs.	700 lbs.	6½ turns.
1.0235	1300 "	650 "	6 "
1.0210	1250 "	600 "	5½ "
1.0185	1200 "	550 "	5 "
1.0160	1150 "	500 "	4½ "
1.0135	1100 "	450 "	4 "
1.0110	1050 "	400 "	3½ "
1.0085	1000 "	350 "	3 "
1.0060	950 "	300 "	2 "

REMARKS:—Measure the density of the water at the range with a hydrometer; charge the air flask to the corresponding pressure in the table and set the regulator for the corresponding number of turns. The table can be used to get the regulator adjustment when from any cause the flask is under-charged.

It will take about an hour to obtain the data for such a table from any torpedo, and perhaps half an hour to tabulate it.

The Whitehead torpedo loses 1050 pounds pressure in an

800-yard run, so that a uniform run can only be maintained with about 300 pounds engine pressure when the torpedo has been fully charged. This would give slow speed, and as a matter of fact the regulator is set for at least twice this engine pressure and the torpedo is slowing rapidly after 600 yards. This is perhaps the chief cause of inaccuracy at the 800-yard range, and 600 yards may be assumed to be the maximum effective range of the Whitehead now in our service.

Mishaps; their Probable Causes and Remedies.

1. *Torpedo fails to run.*—It will be driven about thirty yards by the powder impulse and will then lie idle on the surface or sink, according to the density of the water. Approach the torpedo cautiously, being careful not to jar it or strike its propellers until the starting lever is closed, for its engines may be on the center, and if accidentally thrown off, the torpedo would bolt and run wild. If the starting lever is not thrown back the trouble is with the tripping latch in the tube. If you find the lever thrown back, see if the lock has been left on the propellers. If all else seems right, see if the stop valve is open.

2. *Torpedo sinks.*—Locate it by the rising bubbles and buoy the spot promptly. Grapnels, oyster rakes, purse nets and shark hooks are all good things to use in recovery, but if a diver is available he should be sent down without delay. The torpedo, being almost buoyant, may be drifted some distance by currents each time it is disturbed when dragging for it, and its location might thus ultimately be lost. When recovered, locate the flooded compartment. If it is the immersion chamber, see (a) if the drain plugs have been left out, (b) if the depth index jamb-nut is loose, (c) if the hydrostatic piston diaphragm is torn, (d) if the outside shell is punctured, (e) if the steering rod bell-crank stuffing box needs packing, or (f) if the bulkhead gasket is worn out.

If it is the after body, see (a) if the drain plugs have been left out, (b) if the sinking valve is unseated, (c) if the outside shell is punctured, (d) if the bulkhead gasket is worn out, or (e) if the after stuffing boxes are tight.

Lateral Deviation.—This may be due to slight eccentricities in the torpedo's form, to its not leaving the tube in the exact direction of the axis of the bore, to air leaks, or to the unequal sluing efforts of the tandem propellers.

The torpedo is made as nearly symmetrical in form as is mechanically possible, and its remaining eccentricity should be easily compensated by the vertical rudders.

The torpedo fits loosely in its tube except in the wake of the compression band. As soon as its greatest diameter has passed this band the impulse gases might throw its tail on a slight slant one way or the other according to their wave motion at that moment. Such is generally found to be the case, and for any one tube the slant produced appears to be about the same in amount and direction if the same weight of impulse charge is used. This is, therefore, a permanent angle of error to be allowed for in training the tube.

All air leaks will be into the engine room. The engine room shell is perforated in a great many places, but all holes in it except three are either on top or are symmetrically distributed.

Air leaking into the engine room during a run will promptly rise to its crown and should find sufficient outlet upward through the various holes there, but if the leakage is rapid the air may seek egress through the two holes on the starboard side through which tool No. 4 is inserted to set up the joint screws connecting the air pipe to the valve group. Such egress would tend to throw the tail of the torpedo to port and cause it to deviate in a curve to the right. This theory has been advanced by several experienced torpedoists. To test it I permitted an appreciable air leak into the engine room of torpedo No. — and gave it two runs with vertical vanes at 0°. Before the second run I closed the two unsymmetrical holes in the starboard side with cork plugs sheared close to the skin of the torpedo. The deviation was practically the same in each case: about 75 yards to the right at 400 yards from the ship. I then tightened the leaky joint, removed the plugs and again ran the torpedo with the same result. It seems to me, therefore, that the effect of air leaks upon the course of the torpedo is immaterial, and I look for the cause of lateral deviation in another direction. Experience has shown that the deflection is, before adjustment, almost invariably to the right. This indicates that in designing the propellers no account is taken of the greater sluing effect of the after propeller due to its greater distance from the center of gravity of the torpedo. Considering the lower blades only, they being in the denser water and having the preponderating effect, it will be seen that, if the

blade areas are equal, the after lower blade in its sweep to starboard has a tendency to slue the tail to the left, greater than that of the forward lower blade in the opposite direction, because the leverage around the center of gravity is greater; consequently the torpedo should deviate to the right. To compensate for this the forward propeller should have greater blade area than the after one, or, by formula, if:

A = area of forward propeller blades.

A' = area of after propeller blades.

P = pressure per unit area on blades at right angles to axis of torpedo when propellers are revolving.

R = distance of center of effort on forward blades from center of gravity.

x = distance between center of efforts of blades, then

$$P\,A\,R = P\,A'\,(R + x) \text{ or } A\,R = A'\,(R + x)$$

$$A = A'.\,\frac{R + x}{R}.$$

Using actual data from scale drawings we have:

$R = 78.25$ inches; $x = 2.25$ inches, hence

$$A = \frac{80.50}{78.25}.A' \text{ or } A = 1.03A'.$$

The area, therefore, of the forward propeller blades should be nearly three hundredths greater than that of the after ones.

As a matter of fact the chief object of the tandem propellers is to prevent the rolling, or counter-revolution, of the torpedo which would be caused by one propeller, so the propellers are turned out at the factory with as nearly equal blade areas as is mechanically possible; but at the trial station the rolling register is employed, and the ends of the blades filed off arbitrarily until rolling is eliminated. No consideration, then, can be given to their sluing effects; in fact if the forward blades chance to be the ones reduced to prevent rolling, the sluing effect will be aggravated. It is evident that the blade areas cannot be adjusted to compensate for *both* rolling and sluing effects, nor can the speed of propellers be differentiated to counteract one without aggravating the other evil. It would be better, therefore, to design or finish the propellers to equalize their sluing efforts, and correct the rolling effect by a greater metacentric height, or by an adjustment of ballast in trial runs.

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CONTENTS.

TORPEDOES IN EXERCISE AND BATTLE. By Lieutenant J. M. Ellicott, U. S. N., ... 413

WASHINGTON'S FORGOTTEN MAXIM. Address of Hon. Theodore Roosevelt, ... 447

THE CONSOLIDATED MESS OF THE CREW OF THE U. S. S. INDIANA. By Lieutenant Benton C. Decker, U. S. N., ... 463

THE SAILOR IN THE REVOLUTION. By Commander C. F. Goodrich, U. S. N., ... 469

THE DEVELOPMENT OF SMOKELESS POWDER. By Lieutenant John B. Bernadou, U. S. N., ... 495

THE NAVAL POLICY OF AMERICA AS OUTLINED IN MESSAGES OF THE PRESIDENTS OF THE UNITED STATES, FROM THE BEGINNING TO THE PRESENT DAY. By Hon. Theodore Roosevelt, ... 509

NOTES ON THE YACHT "DEFENDER" AND THE USE OF ALUMINUM IN MARINE CONSTRUCTION. By Richmond Pearson Hobson, Asst. Naval Constructor, U. S. N. (Continued from No. 82.) 523

Discussion:

TORPEDOES IN EXERCISE AND BATTLE.

Lieutenant H. C. Poundstone, U. S. N., 563.—Lieutenant R. C. Smith, U. S. N., 563.

THE CONSOLIDATED MESS OF THE CREW OF THE U. S. S. INDIANA.

Lieutenant-Commander E. B. Barry, U. S. N., 566.—Lieutenant-Commander Daniel Delehanty, U. S. N., 566.—Captain C. M. Chester, U. S. N., 569.—Lieutenant W. F. Fullam, U. S. N., 570.—Captain A. S. Barker, U. S. N., 571.

CONTINUED DISCUSSION OF ESSAY BY DOHRMAN. (See No. 82.)

John S. Watters, Commander, La. N. M., 572.

PROFESSIONAL NOTES, ... 575

The Protection of Warships.—New Torpedo Tube for Japanese Battle-Ship Fuji.—Cylindrical Water-tight Door.—Trial of Sims-Dudley Gun.—England's Fleet Manœuvres.—Tests of Armor and Shell.—Ships of War.

BOOK NOTICE, ... 597

BIBLIOGRAPHIC NOTES, ... 599

OFFICERS OF THE INSTITUTE, ... 615

SPECIAL NOTICE.—Naval Institute Prize Essay, 1898, ... 616

ADVERTISEMENTS.

The condition of the sea, the angle of train and the speed of the ship will affect the course of the torpedo by deflecting it as it enters the water. The deflection so caused is being studied by officers connected with the Torpedo Station, and should also be carefully studied by all who have an opportunity to handle the weapon afloat, especially the deflection produced on a torpedo fired abeam when the ship is running at her probable battle speed. Incomplete experiments so far indicate about 1° deflection per knot of speed.

Broaching, Running Deep, or Irregular Immersion.—From an above-water launching tube a torpedo takes an initial dive, and the depth of this dive will depend upon (a) the height from which the torpedo falls, (b) the angle at which it enters the water, (c) the angle at which the horizontal rudder is locked, (d) the length of time this rudder is locked, and (e) the density of the water. The angle of entry into the water depends upon (f) the depression of the tube, and (g) the weight of the impulse charge. A perfect dive should take the torpedo exactly to its adjusted plane of immersion, bring it to a horizontal position just as it reaches that plane, and leave it at that moment under automatic control. With practice this result can be quite closely attained, and the sure guide in diagnosing the behavior of the torpedo during its initial dive is the depth register card. The figures here given illustrate some faulty dives and suggest their causes and the remedies. The dotted curve in each figure indicates a perfect dive.

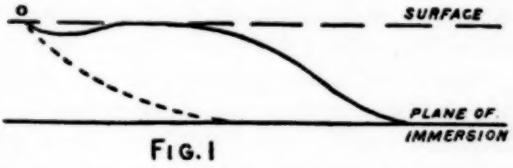

FIG. 1

FIG. 1.—Torpedo scarcely dives at all, then broaches, then seeks its depth automatically. Give the tube more depression, or, if the tube is fixed, decrease the impulse charge.

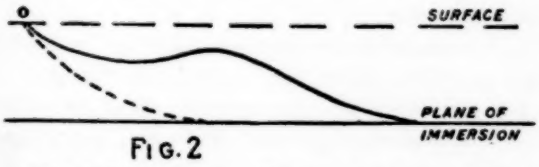

FIG. 2

FIG. 2.—Initial dive still insufficient, and a tendency to broach. There is too much up-rudder when locked. Reset it by the locking star, even making it a little down if necessary.

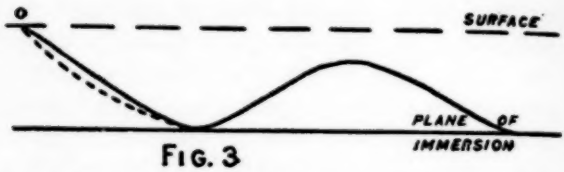

FIG. 3

FIG. 3.—Initial dive sufficient; followed, however, by a tendency to broach. The horizontal rudder was locked too long. Set the immobilizing gear a fewer number of teeth.

FIG. 4

FIG. 4.—Initial dive too great. Set the locking star so that the horizontal rudder will be locked a little more up, or give the tube less depression.

In these adjustments we are again confronted with the effect of the density of the water. In sea water (density 1.026) the torpedo, after its initial dive, has a tendency to bob up to the surface until the horizontal rudder is released and controls it. If the density of the water is less than 1.02, however, the torpedo has a tendency to keep on down while the rudder is locked, unless it is locked a little up. A broach in brackish or fresh water will only occur when the rudder is locked a little up and too long. A torpedo whose initial dive in sea water has been adjusted will, in fresh or nearly fresh water, take a dive such as is shown in Fig. 4, and must be readjusted for the new condition. In fact the dive is likely to be very deep and the torpedo may strike bottom.

A surface run indicates that the rudder has remained locked or partially so, or that the steering engine has jammed. In the first case there will be a rapid series of broaches, and in the latter a continuous surface run.

Broaching in smooth water does not affect the torpedo's course, but in rough water the deflection might be anything.

Torpedo runs away; i. e., runs until beached or until all air is exhausted. If it makes a surface run it is a sure sign that the pawls have failed to operate the ratchet wheel. If it is a run

below the surface and the rudder was properly locked and distance gear set, it is evident that the ratchet wheel has operated all right, but that the friction cams have slipped over each other. In the open sea or with a clean beach beyond the range, running away need cause no anxiety.

Dents such as a torpedo gets in ordinary handling are of little consequence. The head may be very much deformed and even the after body indented without any appreciable change in a torpedo's accuracy. Nevertheless, indentations should be beaten out with a copper maul having a rounded surface, using a wooden block on the outside of the shell as an anvil, hollowed to the shape of the injured surface.

The Whitehead torpedoes of latest pattern abroad are 16.5 feet long, have three-bladed propellers, make 31 knots, and have an extreme range of 1000 yards and a charge of 175 pounds of gun cotton. A similar type is now to be built in the United States. The omission of sinking gear in these new torpedoes is a step in the right direction, but other auxiliary gear could just as well be omitted or modified, and upon this subject I venture to make some suggestions.

1. If the spring of the hydrostatic piston were permanently set to balance it at a depth of eight feet below the surface, no depth index would be necessary, for at that depth a torpedo would hit the unprotected hull of any vessel worthy to be attacked. If the torpedo's plane of immersion varied three feet either way from that for which set, which is outside the limit of probability, there would be no loss of destructive effect. The gain would be one less adjustment to look after, one less possible leak in a very vital part, and the saving in cost and labor for several small, carefully finished parts.

2. I believe that the present distance gear and the locking gear could also be omitted. The initial dive can be controlled within sufficient limits by the depression of the tube or by varying the impulse charge, or by combining both methods.

3. It is mechanically possible so to construct the reducing valve that when flask pressure is down to engine pressure the regulator spring will push the controlling valve far enough up to open a permanent air connection to the top of the reducing valve and thereby to close it. Thus the regulator spring would become a distance regulator, and the torpedo would be stopped when the

air pressure in the flask had fallen to that at the engine; as should be the case, for the effective range of the torpedo is the distance over which a uniform and sufficient speed can be maintained. The course of a torpedo after that is no more to be relied upon than the ricochet of a shell. I believe this effective range to be, with our present Whitehead, about 600 yards, and I think our adjustment cards should be prepared for that range only, instead of for 400 and 800 yards.

4. The transportation screw, projecting as it does far beyond the shell, is in imminent danger of being broken short off during handling, thus disabling the torpedo until the broken shank can be drilled out of the shell and pendulum bob. Its use, moreover, is practically unnecessary; in fact I have seen torpedoes handled, even to turning them upside down, at the Torpedo Station and at the Bliss Company's proving station, without using the transportation screw at all. The transportation screw may, therefore, be discarded. There is none used in the Howell, yet it has two pendulums instead of one.

5. The present elevating gear for between-deck broadside launching tubes, such as is installed in many of our men-of-war, is an abomination, as it takes from five to ten minutes and the labor of two men, turn and turn about, to depress the tube five degrees. A tube cannot always be laid at its approximate depression before loading the torpedo into it, because it has often to be nearly level in order to receive the torpedo from the trolley. Moreover, in battle it may happen that water-line punishment will give the ship a list of several degrees, and the depression of the tube would have to be quickly changed to counteract this. The old differential elevating screw fitted to our VIII-inch muzzle-loading guns is what we want for torpedo tubes.

6. The loading tray for a launching tube is a clumsy and useless contrivance and should be abolished.

7. The doors of launching tubes should swing through at least 180°, for as at present fitted, swinging only about 90°, they mask the orifice for reaching the valve star and locking star of the horizontal rudder, so that these cannot be adjusted, or their adjustments verified, while charging a torpedo in the tube.

THE HOWELL TORPEDO.

The preliminary remarks about assembling the Whitehead are equally applicable to the Howell. If it is already assembled it should be taken apart and inspected, for parts may be found tied with twine, gaskets may be found worn out or hardened, and the after section may be found so shipped that the propeller shafts are not entered in their sockets. Such was the condition of one Howell as I found it assembled. When the after section of the Howell is separated from the middle section, care must be taken *not to turn one propeller independently of the other*, for the eccentric shaft is geared to both propeller shafts by worm wheels which may be broken if one is forced to turn while the other is stationary.

The use of a heaver in the calcium phosphide or depth register pockets *must be absolutely prohibited.* It is a great temptation to a blue-jacket to ship a handspike in one of these pockets in sluing the torpedo for any purpose, especially when connecting up the head by the bayonet joint, and if the solder of these pockets is broken the torpedo will be flooded during its run.

The rod carrying the balance weights in the exercise head should be taken out, and the distance of the weights from one end of the rod measured and recorded. The number of threads to the inch on this rod should also be measured and recorded, so that alteration of trim can be made systematically.

An index, similar to the depth index of the Whitehead, might be fitted over the forward end of this rod to show the longitudinal position of the balance weights at any time. It may well be remarked here, however, that the Howell torpedo may be considerably out of trim by the head, either up or down, without seriously affecting its run.

Use of Locking Gear.

The locking gear of the Howell must certainly be used when firing from the bow tube of a vessel under way, for the speed of the vessel plus the speed of discharge is greater than the speed of the torpedo in the water, and the consequent retardation causes the pendulum to swing forward for an appreciable length of time, giving up-rudder and sometimes causing the torpedo to broach. Under other conditions the speed in air and water are about the

same, the retarding is but momentary, and neglect to use the locking gear will generally be of no consequence. The abolition of bow tubes, and increased speed for new Howells, may make locking gear wholly unnecessary.

Effect of the Density of the Water.

The density of the water more seriously affects Howell torpedo exercise than Whitehead. Our present service Howell, ready for an exercise run, weighs 510 pounds and has a reserve buoyancy in sea water (specific gravity 1.026) of ten pounds. A simple calculation will show that this torpedo is not buoyant in water whose specific gravity is less than 1.012. I weighed two Howells in water of specific gravity 1.005 and they weighed four pounds each, which agreed exactly with their weight by calculation. When hoisted out of the water they were found perfectly dry inside. In water absolutely fresh the Howell will weigh about 5 pounds. If, therefore, a Howell is fired in water whose specific gravity is less than 1.012, it will sink at the end of its run and may be lost. This limits safe exercise with this torpedo to seaboard waters, unless some scheme is devised which will make it more buoyant. My first expedient to this end was to use the water space in the exercise head as a buoyancy chamber, filling the regular buoyancy chamber with water and running the balance weights as far forward as possible, but the torpedo could not be trimmed, even with additional weights on the nose, and floated vertically, nose up. I would therefore suggest that a wooden disc of sufficient size to give the buoyancy desired be placed in the exercise head. A disc of seasoned pine 11 inches in diameter, 9 inches long and with an axial hole large enough to allow the block to slip over the casing of the trimming weights, would make the torpedo buoyant in fresh water. I believe that the trim can then be readjusted with the sliding weights alone.

Notwithstanding its lack of buoyancy, the Howell can be recovered after an exercise run in fresh or brackish water if it is trimmed tail heavy, by recapturing it before it has entirely run down. The propellers keep its nose bobbing to the surface at the end of the range as long as they revolve. This method, however, is too risky to be recommended.

Howell torpedo tubes thus far installed in our vessels have been almost all fixed bow tubes, and it is intended that they

should have a permanent depression of 3°. When there are but few stores on board, however, this depression almost disappears. I have been compelled to use a bow tube at ¾° elevation. The first torpedo thus fired was discharged with the usual 6 oz. of cubical black powder. It was badly ejected, swung downward at a great angle and dove almost perpendicularly to the bottom (18 feet). Then I increased the charge to 8 oz. and obtained a perfect dive.

It is very important to note, when steam is first turned on the motor, the direction in which the propellers of the Howell revolve. The upper blades should turn toward each other, yet it is possible to assemble the Dow motor in such a manner that it will drive the flywheel backwards and make the torpedo run astern when launched. Such a blunder was made on the practice vessel Bancroft at the U. S. Naval Academy, and the result is worth describing:

Serious leaks in the steam pipes leading to the Dow motor on that vessel were discovered in exercise. When the engineer's force repaired the leaks they took the motor to pieces, presumably to learn something about it. The driving discs of the motor were marked " R " and " L," and the casing was similarly marked, *but these shop marks were wrong* and the motor had not been originally assembled by them. Not noting this, however, and being wholly unfamiliar with the machine, the men employed upon it reassembled it according to the marks, thus reversing the driving discs. Now, although this change throws the ports in both fixed and driving discs into the same general alignment, this alignment has a spiral trend, enough to produce rotation in the opposite direction to that originally intended.

Preparations to fire were made some days after this. The speed ran up slowly, but this was attributed to long leads and reduced boiler pressure. The possibility that the motor had been assembled wrong was naturally not suspected, and if it had been it is probable that the drill officer would have dismissed the suspicion when the motor revolved at all, for he might reasonably have regarded its rotation impossible with driving discs reversed.

As the delay in getting full speed was holding back a great-gun target practice, it was determined to fire with 6000 revolutions. The torpedo dove very prettily, then came to the surface tail foremost almost precisely where it went down, and fell flat upon

the water with its tail slued to starboad. It gathered sternboard quickly and circled rapidly to starboard tail foremost in a circle about equal in radius to the weapon's length, having an undulating motion, approaching and receding from the surface at an average depth of about four feet (for which it was set). After three or four complete turns it gradually settled to the bottom, still circling as long as visible. The spot was buoyed, and after nine days of unremitting effort, during which oyster rakes, grapnels and drag nets were used, the torpedo was recovered, near the spot where lost, by a fisherman with a bent iron rod on the end of a clothes line. He hooked it through the tail frame. The following injuries were then noted:

1. The middle and after sections had nearly half filled with water which had gradually seeped in during nine days, for this water did not leak out at all when the torpedo was landed on the dock and turned over and over.

2. The depth register pocket was full of water, the main spring of the depth register clockwork destroyed by corrosion, and the curve on the card obliterated.

3. The pitch trigger had operated during the initial dive, allowing the reverse motion of the cam gear to break and bruise several teeth in the gear wheels, for the pitch cam was set back to the end of its slot before discharge. The trigger, however, had been thrown up again as the torpedo backed to the surface, and remained so.

4. The port worm wheel on the eccentric shaft had been torn from its hub.

5. All steel parts outside the shell were so eaten away by galvanic action that another nine days' immersion might have ruined them.

One serious drawback to exercise with the Howell is its lack of distance gear. It can only be recovered upon running down, after an interval of 1½ to 3½ minutes from the moment of discharge. During 45 seconds of this time it is quite rigidly on its course in the line of fire, but during the remaining time it may be swept far from the point where it is expected to bring up, and, unless its probable direction is shrewdly guessed, it may be lost. With a moderate breeze and in bright sunlight the phosphide gives but a faint and spasmodic flicker, almost unnoticeable be-

yond one hundred yards from the search boat. When the torpedo loses its rigidity it generally deviates to the left, and its extreme range to a full stop is about 850 yards. The method suggested for plotting Whitehead target practice at sea would, therefore, be of no value for the Howell. Remembering this distance and deviation, and also that if you can lie to leeward of the Howell's course the smell of the phosphide will probably lead you to it, you are somewhat guided in your preparations for recovery. There are four ways of fitting distance gear which seem to be mechanically possible:

1. Cam gear which will produce zero pitch of propeller blades at the desired time in the run.

2. Cam gear to give infinite pitch. This would bring the greatest resistance of the water on the blades and shorten the spin of the flywheel.

3. A device to release the blades from control in their sockets at the end of the desired range, and allow them to pivot into the position of least resistance.

4. Automatic sliding couplings on the propeller shafts to uncouple at the end of the desired run.

Of these I believe the third would be the simplest, and it would add nothing to the load on the flywheel during the run.

Suggested Modifications in the Howell.

The screw fan on the exercise nose is an unnecessary attachment.

The slotted bulkhead nuts with screw-driver wrenches are awkward and vexatious to set up and should be replaced by hexagonal nuts and socket wrenches.

A manifolding oil pot should be located over the many oilways of the immersion regulating gear, with feeders to each of them. It could be filled through a filling hole in the top of the shell, closed by a tap screw, and thus much time would be saved in oiling and no bearing could be overlooked.

A larger number of spare parts should be furnished, and especially a spare set of propeller blades, for these are easily and almost always curled up or broken if the torpedo grounds.

Although the effective range of the present Howell is only claimed to be 400 yards, trials at Tiverton have shown it to make repeated 600 yard runs at an average speed of 19.5 knots, with a

mean lateral error of 6 yards and at set depth. For the sake of uniformity, therefore, the effective range of both the Whitehead and Howell torpedoes now in our service may be set down as 600 yards; remembering that the Whitehead will cover that distance in 40 seconds, and the Howell in one minute.

BATTLE PRACTICE.

Practice with torpedoes having exercise heads is not sufficient to insure their effective use in battle, and it is imperative that commanders be instructed to expend at least one torpedo of each kind a year, with war head attached, against a target which will demonstrate its destructive efficiency. For the purpose of stimulating proficiency and forecasting the yearly expenditure, it might be made a regulation that every ship which, after adequate target practice, lost no torpedoes during a year, should expend one torpedo with war head attached under the nearest possible approximation to battle conditions. Derelicts, hulks and condemned vessels should be the targets used. Such practice might cost in the aggregate $100,000 a year, but until it is allowed, a torpedo officer is like the small boy who has permission to swim but is forbidden to go near the water.

Every officer who has studied torpedoes should give his views upon their use in battle, for there will be nothing better than a concensus of opinion to guide us until war comes. Some important questions which should be decided are: How should the torpedoes be installed? by whom should their discharge be controlled, and when should they be used against the enemy in a fleet engagement?

INSTALLMENT.

I am convinced, from a careful study of the tactical game and tactical situation at the War College, and from the statements of thoughtful writers upon the subject, that ships are not going to fight bows on, but broadside to broadside, and that if a ship's bow is turned toward the enemy within torpedo range of him it is her commander's purpose either to charge through the line or to ram. If it is his intention to charge through, he will bring no vessel in line with his bow torpedo, and if he is endeavoring to ram he risks self-destruction if he is unable, through any of the manifold mischances, to eject his bow torpedo before collision.

A man who attempts to beat another man over the head with the butt of a loaded revolver is committing a folly which may cost him his own life. No warship likely to take her place in the line of battle should have bow torpedo tubes. Broadsides pivot-tubes alone should be fitted, say two on each side. Stern tubes are scarcely worth their space and cost of installment, for a torpedo discharged into the race of a ship's propellers is a mere hazard.

If a torpedo room has no armor protection the torpedoes in it or in the tubes are, in battle, a constant menace to the ship carrying them. An air flask exploded by a shell would probably kill every man in the compartment and wreck all installation, and might even detonate the war head (although I think this unlikely) and destroy the ship. A shell exploding in the war head or a fragment striking the detonator would undoubtedly do so. To carry eight or ten such weapons into battle in unprotected compartments with the merely possible chance of using them is to invite destruction. Torpedo rooms in battle-ships or armored cruisers should be as heavily protected by armor as the most important gun positions. It would be still better if they could be below the water line, under the protective deck, with under-water discharge tubes. We have too long shirked the problem of the under-water discharge, and should take it up at once with a determination to solve it. European nations claim that they have successfully done so.

Control of Fire.

The torpedo is a weapon of opportunity. It must be used when the enemy is within a certain range and on a certain line of bearing. The captain should not be burdened with the collateral duty of watching for this opportunity. An officer should be stationed in a position on deck where he could watch the enemy's vessels and judge by their movements and those of his own vessel when the opportunity was likely to occur. He should be in communication with the torpedo rooms by voice tubes and electric bells or indicators, and should have a torpedo director. He should signal down the angle of train and should be kept informed from the torpedo rooms of the readiness to fire. He should keep himself informed of the speed of his own vessel and should make signal to fire at the proper moment without advice

or suggestion from others, and his signal should be instantly obeyed below. If any delay must follow his signal, the torpedo should not be fired, and he should be immediately informed of the reason why. He need only inform the captain of the result of a successful shot or that he has expended all of his torpedoes. His position might necessarily be an exposed one, yet it is quite possible to place him in an inconspicuous tower which would save him from being an unmistakable target within torpedo range and give him a certain sense of security which would be conducive to coolness and good judgment.

On scout vessels, unprotected cruisers and gunboats, torpedo rooms cannot be protected, and it might be argued that these vessels should not be equipped with torpedoes, but such is not my idea. Equip them, like battle-ships, with broadside tubes. When the duty of such a vessel is scouting and keeping touch with the enemy without becoming engaged, the war heads should be kept below the protective deck without primers and the flasks uncharged, for the torpedoes are then of no use. In the pursuit of merchant vessels or when harassing a convoy there may often come a time when a cruiser has but a few moments in which to strike a destructive blow. At such a time a torpedo will accomplish in thirty seconds what fire or guns could only do in several hours, and would not, like these latter, so widely advertise the presence of the destroyer. When the cruiser is brought to bay by a superior force, every preparation should be promptly made to use her torpedoes, and her chief endeavor should be to get within torpedo range and use them, for she is then in a desperate situation, when a desperate measure alone can achieve her salvation. In this connection it is well to realize how much quicker a war head can be secured on a Howell by its bayonet joint than on a Whitehead by its multitude of joint screws. In specifications for new Whiteheads it would be well to require bayonet joint connections for war and exercise heads.

To be properly prepared for war we should have on hand a large reserve supply of torpedoes. We have, so far, less than 200 Whiteheads and 100 Howells, and of these some few have been expended in exercise. The Hotchkiss Ordnance Company claims that it could turn out at an emergency rate about fifteen Howell torpedoes a month, and the Bliss Company could probably do about the same with the Whiteheads. This would be in-

sufficient, but, what is far worse, there would be no time for trials and inspections, so that perhaps half the weapons would be worthless. We rely upon assembling vast mosquito fleets in a war emergency, a large proportion to be torpedo-boats, but of what use would they be without torpedoes? The British Government has on hand to-day more than three thousand automobile torpedoes, while we, who must still look to the torpedo to make up our great deficiency in other means of coast defence, have scarcely enough to equip our present sea-going navy.

TORPEDO BOATS AND DRILL GROUNDS.

Statements are being made in the public prints that it is contemplated to select a site for a depot where our torpedo flotilla may be kept in ordinary, equipped, repaired and exercised; and two places have been mentioned as under consideration, viz: Boston and Newport. That we shall soon need such a depot is very true, but let us select the site absolutely on its merits. The following considerations, and perhaps others, should enter into the selection:

1. The depot should be centrally located in the probable theater of defensive operations.

2. It should rest upon the chain of interior waterways which parallels our Atlantic Coast.

3. It should be near a body of water suited for torpedo boat drill and torpedo exercise.

4. It should have communication by interior commercial routes with torpedo and explosive manufactories and sources of general supply.

5. It should be beyond the reach of a hostile raid from the sea.

6. It should possess the tactical advantage of various outlets for sorties, or, in a last extremity, for escape and retreat to other bases.

7. Its approaches should be capable of complete protective surveillance and strong defence.

Of these seven conditions Boston fails to satisfy all but the 4th, and Newport meets only the 1st, 3d and 4th. The advantage lies with Newport, which still falls short of more than half the requirements. The proper solution of the problem lies in working from the requirements to the selection.

The probable theater of defensive operations is our Atlantic coast from Penobscot to Chesapeake Bay. Conditions 1 and 2 must, therefore, be satisfied somewhere between Nantucket and New York. Condition 3 throws the balance of favor toward Long Island Sound. Condition 5 retires us into Little or Great Peconic Bay. Here we will find conditions 6 and 7, with a little artificial work, admirably satisfied, and it only remains to find a site on these bays which will satisfy condition 4. Following out the railroads of Long Island brings us to Jamesport and New Suffolk; both good sites, but the former unnecessarily retired.

New Suffolk is, then, to my mind, an ideal site for a torpedo arsenal. In the basin between the town, Little Hog Neck and Robbins' Island a hundred torpedo-boats could lie secure in all weathers. Along the stretch of beach from the town to the Neck there is room for as many marine railways as may be desired, backed with gently sloping ground for shop sites. Robbins' Island, right at hand and now only used by a gun club, would afford an excellent depot for explosives. The Long Island Railroad, which now passes at Cutchoug, 2½ miles from New Suffolk, would quickly build a branch to the latter place if an arsenal were established there, thus giving short and direct communication with the Bliss (Whitehead) torpedo works in Brooklyn and with all sources of supply through New York. Howell torpedoes could be transported from Providence *via* New London and across the Sound by regular commercial routes, or brought by water direct from the manufactory.

A hostile force seeking the New Suffolk depot would have to pass first through Gardiner's Bay, a place which would almost surely be held by our fleet, and thence through the narrow and tortuous channels around Shelter Island, which are capable of the strongest defence. If necessary, our torpedo flotilla could retire behind Robbins' Island, gaining a second line of defence as strong as the outer one. The flotilla would not even then be in a *cul de sac*, for Shinnecock Canal connects Great Peconic Bay with Shinnecock Bay, and will in a few months connect the latter with the Atlantic Ocean, while further cuts now existing at Quog and to the westward would, with some improvement, give an interior waterway along the whole south side of Long Island to New York. These various canals are under the supervision of the New York State Engineers and, along with the Erie Canal,

are now being improved under a liberal appropriation. They are all actually existing cuts to-day, only lacking from one to three feet in depth for torpedo-boat navigation. The Shinnecock and Quog Canals will be thus deepened within a year.

Jamesport and Riverhead lie at the head of Great Peconic Bay as bases of supply on the same line of communications with New Suffolk, if the flotilla is cut off from the latter place.

Gardiner's and the Peconic Bays form an ideal sheet of water for all torpedo-boat exercises. Enormous mosquito fleets can be manoeuvered, strategic exercises by night and day carried out, and torpedo target practice conducted on the most comprehensive scale. Operations in connection with the main fleet can be carried on without constriction. Perfect anchorages for small craft abound, such as Orient Harbor, Deerings Harbor, Noyack Bay, New Suffolk and the Peconic River. Excellent markets will be found at Sag Harbor and Greenport, only three hours by rail from New York. The Bliss Company's regular Whitehead proving ground is now Noyack Bay.

Certain improvements should be made in connection with the choice of New Suffolk as a torpedo arsenal. I shall not dwell upon the deepening of the canals mentioned, for that is already being done by the New York State Engineers; nevertheless there should be an *entente* with them in order that their work shall fully satisfy the needs of the proposed arsenal. Orient Harbor and Long Island Sound should be connected by a cutting at "Dam Pond" (also locally known as "Mud Pond"), two miles west of Orient Village, where nothing but a parapet of cobbles eighty feet wide and ten feet high now separates these waters. An interior route into Long Island Sound would thus be obtained, so that torpedo-boats could enter the Sound from the Peconic Bay district without passing out into Gardiner's Bay. Finally, the creek behind Ram Head could be utilized as a place of concealment for torpedo-boats before a sortie, or as an impregnable harbor of refuge, if its entrance were deepened one foot and the sand-spit connecting Ram Head to Shelter Island were cut through.

It is true that the Peconic system will be frozen during at least three months of the year, but so will any other available place fulfilling a majority of the requirements. It may be well to have a second depot and drill ground for winter work and a rendezvous should we have to fight in winter, somewhere near or

south of Norfolk, but to discuss that now would be attempting to cross a bridge which is still a long way off.

A certain percentage of our coming torpedo flotilla should be kept constantly in commission, and, for officers so employed, duty on torpedo-boats should count as a cruise, for no labor afloat will be more arduous than theirs. Command of torpedo-boats should be given to officers whose next subsequent sea duty would be as navigators, for such duty will be an excellent school of instruction in navigating our home waters. Officers and crews should shift from one boat to another at regular periods in order that every torpedo-boat in the service might be kept up to cruising efficiency. From April to November a regular program of exercise should be carried out, such as the following:

April and May.—Torpedo target practice under way in Great and Little Peconic Bays, endeavoring to extend the exercise to all boats at the station and to use all their torpedoes.

June.—Night attacks upon vessels of the fleet in various harbors by all torpedo-boats regularly in commission during that month. Similar attacks in foggy weather and under other favorable conditions which might present themselves.

July.—Operations in conjunction with the regular battle fleet manoeuvers; additional torpedo-boats being then commissioned if necessary to bring the torpedo fleet up to at least one for every vessel in the main fleet.

August.—The whole torpedo flotilla commissioned, drawing from the naval militia and officers on shore duty. Mosquito fleet tactics in Gardiner's Bay and the Peconic Bays, with torpedo target practice in fleet formations. This month's work to be directed by the War College with a view to solving tactical problems and even hypothetical strategic situations embracing a large theater of coast operations, by dividing the fleet into opposing squadrons having artificial battle fleet values.

September.—Completion of any unfinished work of previous programs. Summer fleet to go out of commission.

October.—Reconnoissance of harbors, bays and interior waterways with a view to developing plans of defence and preparing war charts. This work to be directed by the War College and performed by those boats kept regularly in commission.

November.—Boats needed for winter manoeuvers to go south and join the main fleet at its rendezvous.

We have the torpedoes and we are building the torpedo-boats. Shall they be as the pound kept laid up in a napkin? They come to us from the inventors and builders only as ingenious and costly mechanical toys, and we are tempted to cast them aside after some passing curiosity because we blunder with them in the first handling; but let us all realize, from the Secretary of the Navy down to the youngest apprentice who handles the torpedoes or serves on the boats, that it rests entirely with ourselves, by constant practice, to make them efficient, destructive weapons and vessels of war.

(*Discussion at end of number.*)

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

WASHINGTON'S FORGOTTEN MAXIM.*

Address of Hon. THEODORE ROOSEVELT,

Assistant Secretary of the Navy, before the Class at the U. S. Naval War College, Newport, R. I., June 2d, 1897.

A century has passed since Washington wrote "To be prepared for war is the most effectual means to preserve peace." We pay to this maxim the lip-loyalty we so often pay to Washington's words; but it has never sunk deep into our hearts. Indeed, of late years many persons have refused it even the poor tribute of lip-loyalty, and prate about the iniquity of war as if somehow that was a justification for refusing to take the steps which alone can, in the long run, prevent war or avert the dreadful disasters it brings in its train. The truth of the maxim is so obvious to every man of really far-sighted patriotism that its mere statement seems trite and useless; and it is not over-creditable to either our intelligence or our love of country that there should be, as there is, need to dwell upon and amplify such a truism.

In this country there is not the slightest danger of an over-development of warlike spirit, and there never has been any such danger. In all our history there has never been a time when preparedness for war was any menace to peace. On the contrary, again and again we have owed peace to the fact that we were prepared for war; and in the only contest which we have had with a European power since the Revolution, the War of 1812, the struggle, and all its attendant disasters, were due solely to the

* "To be prepared for war is one of the most effectual means of preserving peace."—Washington's speech to both Houses of Congress, Jany. 8th, 1790.—*Editor.*

fact that we were not prepared to face, and were not ready instantly to resent, an attack upon our honor and interest; while the glorious triumphs at sea which redeemed that war were due to the few preparations which we had actually made. We are a great peaceful nation; a nation of merchants and manufacturers, of farmers and mechanics; a nation of workingmen, who labor incessantly with head or hand. It is idle to talk of such a nation ever being led into a course of wanton aggression or needless conflict with military powers by the possession of a sufficient navy.

The danger is of precisely the opposite character. If we forget that in the last resort we can only secure peace by being ready and willing to fight for it, we may some day have bitter cause to realize that a rich nation which is slothful, timid or unwieldy is an easy prey for any people which still retains those most valuable of all qualities, the soldierly virtues. We but keep to the traditions of Washington, to the traditions of all the great Americans who struggled for the real greatness of America, when we strive to build up those fighting qualities for the lack of which in a nation, as in an individual, no refinement, no culture, no wealth, no material prosperity, can atone.

Preparation for war is the surest guarantee for peace. Arbitration is an excellent thing, but ultimately those who wish to see this country at peace with foreign nations will be wise if they place reliance upon a first-class fleet of first-class battle-ships, rather than on any arbitration treaty which the wit of man can devise. Nelson said that the British fleet was the best negotiator in Europe, and there was much truth in the saying. Moreover, while we are sincere and earnest in our advocacy of peace, we must not forget that an ignoble peace is worse than any war. We should engrave in our legislative halls those splendid lines of Lowell:

> "Come, Peace! not like a mourner bowed
> For honor lost and dear ones wasted,
> But proud, to meet a people proud,
> With eyes that tell o' triumph tasted!"

Peace is a goddess only when she comes with sword girt on thigh. The ship of state can be steered safely only when it is always possible to bring her against any foe with "her leashed thunders gathering for the leap." A really great people, proud

and high-spirited, would face all the disasters of war rather than purchase that base prosperity which is bought at the price of national honor. All the great masterful races have been fighting races, and the minute that a race loses the hard-fighting virtues, then, no matter what else it may retain, no matter how skilled in commerce and finance, in science or art, it has lost its proud right to stand as the equal of the best. Cowardice in a race, as in an individual, is the unpardonable sin; and a wilful failure to prepare for danger may, in its effects, be as bad as cowardice. The timid man who cannot fight, and the selfish, short-sighted or foolish man who will not take the steps that will enable him to fight, stand on almost the same plane.

It is not only true that a peace may be so ignoble and degrading as to be worse than any war; it is also true that it may be fraught with more bloodshed than most wars. Of this there has been melancholy proof during the last two years. Thanks largely to the very unhealthy influence of the men whose business it is to speculate in the money market, and who approach every subject from the financial standpoint purely; and thanks quite as much to the cold-blooded brutality and calculating timidity of many European rulers and statesmen, the peace of Europe has been preserved, while the Turk has been allowed to butcher the Armenians with hideous and unmentionable barbarity, and has actually been helped to keep Crete in slavery. War has been averted at the cost of more bloodshed, and infinitely more suffering and degradation to wretched women and children, than have occurred in any European struggle since the days of Waterloo. No war of recent years, no matter how wanton, has been so productive of horrible misery as the peace which the powers have maintained during the continuance of the Armenian butcheries. The men who would preach this peace, and indeed the men who have preached universal peace in terms that have prepared the way for such a peace as this, have inflicted a wrong on humanity greater than could be inflicted by the most reckless and war-loving despot. Better a thousand times err on the side of over-readiness to fight than to err on the side of tame submission to injury or cold-blooded indifference to the misery of the oppressed.

Popular sentiment is just when it selects as popular heroes the men who have led in the struggle against malice domestic or foreign levy. No triumph of peace is quite so great as the

supreme triumphs of war. The courage of the soldier, the courage of the statesman who has to meet storms which can be quelled only by soldierly qualities, this stands higher than any quality called out merely in time of peace. It is by no means necessary that we should have war to develop soldierly attributes and soldierly qualities; but if the peace we enjoy is of such a kind that it causes their loss, then it is far too dearly purchased, no matter what its attendant benefits may be. It may be that some time in the dim future of the race the need for war will vanish; but that time is yet ages distant. As yet no nation can hold its place in the world or can do any work really worth doing unless it stands ready to guard its rights with an armed hand. That orderly liberty which is both the foundation and the cap-stone of our civilization can be gained and kept only by men who are willing to fight for an ideal; who hold high the love of honor, love of faith, love of flag, and love of country. It is true that no nation can be really great unless it is great in peace, industry, integrity, honesty. Skilled intelligence in civic affairs and industrial enterprises alike; the special ability of the artist, the man of letters, the man of science and the man of business; the rigid determination to wrong no man and to stand for righteousness, all these are necessary in a great nation. But it is also necessary that the nation should have physical no less than moral courage; the capacity to do and dare and die at need, and that grim and steadfast resolution which alone will carry a great people through a great peril. The occasion may come at any instant when

> "'Tis man's perdition to be safe
> When for the truth he ought to die."

All great nations have shown these qualities. The Dutch held but a little corner of Europe. Their industry, thrift and enterprise in the pursuits of peace, their cultivation of the arts, helped to render them great; but these qualities would have been barren had they not been backed by those sterner qualities which rendered them able to wrest their freedom from the cruel strength of Spain and to guard it against the banded might of England and of France. The merchants and the artists of Holland did much for her; but even more was done by the famished burghers who fought to the death on the walls of Harlem and Leyden, and the great admirals who led their fleets to victory on the broad and narrow seas.

England's history is rich in splendid names and splendid deeds. Her literature is even greater than that of Greece. In commerce she has stood in the modern world as more than ever Carthage was when civilization clustered in a fringe around the Mediterranean. But she has risen far higher than ever Greece or Carthage rose, because she possesses also the great masterful qualities which were possessed by the Romans who overthrew them both. England has been fertile in soldiers and administrators; in men who triumphed by sea and by land; in adventurers and explorers who won for her the world's waste spaces; and it is because of this that the English-speaking race now shares with the Slav the fate of the coming years.

We of the United States have passed most of our few years of national life in peace. We honor the architects of our wonderful material prosperity; we appreciate the necessity of thrift, energy and business enterprise; and we know that even these are of no avail without the civic and social virtues. But we feel, after all, that the men who have dared greatly in war, or the work which is akin to war, are those who deserve best of the country. The men of Bunker Hill and Trenton, Saratoga and Yorktown, the men of New Orleans and Mobile Bay, Gettysburg and Appomattox, are those to whom we owe most. None of our heroes of peace, save a few great constructive statesmen, can rank with our heroes of war. The Americans who stand highest on the list of the world's worthies are Washington, who fought to found the country which he afterwards governed, and Lincoln, who saved it through the blood of the best and bravest in the land; Washington, the soldier and the statesman, the man of cool head, dauntless heart and iron will, the greatest of good men, and the best of great men; and Lincoln, sad, patient, kindly Lincoln, who for four years toiled and suffered for the people, and when his work was done laid down his life that the flag which had been rent asunder might once more be made whole and without a seam.

It is on men such as these, and not on the advocates of peace at any price, or upon those so short-sighted that they refuse to take into account the possibility of war, that we must rely in every crisis which deeply touches the true greatness and true honor of the republic. The United States have never once in the course of their history suffered harm because of preparation for war or because of entering into war. But we have suffered incalculable

harm again and again from a foolish failure to prepare for war or from reluctance to fight when to fight was proper. The men who to-day protest against a navy, and protest also against every movement to carry out the traditional policy of the country in foreign affairs, and to uphold the honor of the flag, are themselves but following in the course of those who protested against the acquisition of the Great West and who failed to make proper preparations for the War of 1812, or refused to support it after it had been made. They are own brothers to the men whose shortsightedness and supine indifference prevented any reorganization of the *personnel* of the navy during the middle of the century, so that we entered upon the Civil War with captains seventy years old. They are as close kin to the men who, when the Southern States seceded, wished to let the Union be disrupted in peace rather than restored through the grim agony of armed conflict.

I do not believe that any considerable number of our citizens are stamped with this timid lack of patriotism. There are some doctrinaires whose eyes are so firmly fixed on the golden vision of universal peace that they cannot see the grim facts of real life until they stumble over them to their own hurt, and, what is much worse, to the possible undoing of their fellows. There are some educated men in whom education merely serves to soften the fiber and to eliminate the higher, sterner qualities which tell for national greatness; and these men prate about love for mankind, or for another country, as being in some hidden way a substitute for love of their own country. What is of more weight, there are not a few men of means who have made the till their fatherland, and who are always ready to balance a temporary interruption of money-making, or a temporary financial and commercial disaster, against the self-sacrifice necessary in upholding the honor of the nation and the glory of the flag.

But, after all, these people, though often noisy, form but a small minority of the whole. They would be swept like chaff before the gust of popular fury which would surely come if ever the nation really saw and felt a danger or an insult. The real trouble is that in such case this gust of popular fury would come too late. Unreadiness for war is merely rendered more disastrous by readiness to bluster; to talk defiance and advocate a vigorous policy in words, while refusing to back up these words by deeds, is cause for humiliation. It has always been true, and in this age

it is more than ever true, that it is too late to prepare for war when the time of peace has passed. The short-sightedness of many people, the good-humored indifference to facts of others, the sheer ignorance of a vast number, and the selfish reluctance to insure against future danger by present sacrifice among yet others —these are the chief obstacles in the way of building up a proper navy and carrying out a proper foreign policy.

The men who opposed the War of 1812 and preferred to have the nation humiliated by unresented insult from a foreign power rather than see her suffer the losses of an honorable conflict, occupied a position little short of contemptible; but it was not much worse than that of the men who brought on the war and yet deliberately refused to make the preparations necessary to carry it to a successful conclusion. The visionary schemes for defending the country by gunboats instead of by a fleet of sea-going battle-ships, the refusal to increase the navy to a proper size, the determination to place reliance upon militia instead of upon regularly trained troops, and the disasters which followed upon each and every one of these determinations, should be studied in every school-book in the land so as to enforce in the minds of all our citizens the truth of Washington's adage that in time of peace it is necessary to prepare for war.

All this applied in 1812; but it applies with ten-fold greater force now. Then, as now, it was the navy upon which the country had to depend in the event of war with a foreign power; and then, as now, one of the chief tasks of a wise and far-seeing statesmanship should have been the upbuilding of a formidable fighting navy. In 1812 untold evils followed from the failure to provide such a fighting navy, for the splendid feats of our few cruisers merely showed what could have been done if we had had a great fleet of battle-ships. But ships, guns and men were much more easily provided in time of emergency at the beginning of this century than at the end. It takes months to build guns and ships now, where it took days or, at the most, weeks then; and it takes far longer now to train men to the management of the vast and complicated engines with which war is waged. Therefore, preparation is much more difficult and requires a much longer time; and yet wars are so much quicker, they last so comparatively short a period, and can be begun so instantaneously that there is very much less time than there was formerly in which to make preparations.

No battle-ship can be built inside of two years under no matter what stress of circumstances, for we have not in this country the plant to enable us to work faster. Cruisers would take almost as long. Even torpedo-boats, the smallest of all, could not be put in first-class form under ninety days. Guns available for use against a hostile invader would require two or three months; and in the case of the larger guns, the only ones really available for the actual shock of battle could not be made under eight months. Rifles and military munitions of every kind would require a corresponding length of time for preparation; in most cases we should have to build, not merely the weapons we need, but the plant with which to make them in any large quantity. Even if the enemy did not interfere with our efforts, which they undoubtedly would, it would therefore take from three to six months after the outbreak of a war, for which we are unprepared, before we could in the slightest degree remedy our unreadiness. During these six months it would be impossible to over-estimate the damage that could be done by a resolute and powerful antagonist. Even at the end of that time we would only be beginning to prepare to parry his attack, for it would be two years before we could attempt to return it. Since the change in military conditions in modern times there has never been an instance in which a war between any two nations has lasted more than about two years. In most recent wars the operations of the first ninety days have decided the result of the conflict. All that followed has been a mere vain effort to strive against the stars in their courses by doing at the twelfth hour what it was useless to do after the eleventh.

We must therefore make up our minds once for all to the fact that it is too late to make ready for war when the fight has once begun. The preparation must come before that. In the case of the Civil War none of these conditions applied. In 1861 we had a good fleet and the Southern Confederacy had not a ship. We were able to blockade the southern ports at once, and we could improvise engines of war more than sufficient to put against those of an enemy who also had to improvise them, and who labored under even more serious disadvantages. The Monitor was got ready in the nick of time to meet the Merrimac, because the Confederates had to plan and build the latter while we were planning and building the former; but if ever we have to go to

war with a modern military power we shall find its Merrimacs already built, and it will then be altogether too late to try to build Monitors to meet them.

If this point needs any emphasis surely the history of the War of 1812 applies to it. For twelve years before that war broke out even the blindest could see that we were almost certain to be drawn into hostilities with one or the other of the pair of combatants whose battle-royal ended at Waterloo. Yet we made not the slightest preparation for war. The authorities at Washington contented themselves with trying to build a flotilla of gunboats which could defend our own harbors without making it necessary to take the offensive ourselves. We already possessed a dozen first-class cruisers, but not a battle-ship of any kind. With almost incredible folly the very Congress that declared the war voted down the bill to increase the navy by twenty battleships, though it was probably too late then anyhow, for even under the simpler conditions of that day such a fleet could not have been built and put into first-class order in less than a couple of years. Bitterly did the nation pay for its want of foresight and forethought. Our cruisers won a number of striking victories, heartening and giving hope to the nation in the face of disaster; but they were powerless to do material harm to the gigantic naval strength of Great Britain. Efforts were made to increase our little navy, but in the face of a hostile enemy already possessing command of the seas this was impossible. Two or three small cruisers were built; but practically almost all the fighting on the ocean was done by the handful of frigates and sloops which we possessed when the war broke out. Not a battle-ship was able to put to sea until after peace was restored. Meanwhile, our coast was blockaded from one end to the other, and was harried at will by the hostile squadrons. Our capital city was burned, and the ceaseless pressure of the blockade produced such suffering and irritation as nearly to bring about a civil war among ourselves. If in the first decade of the present century the American people and their rulers had possessed the wisdom to provide an efficient fleet of powerful battle-ships there would probably have been no War of 1812; and even if war had come, the immense loss to, and destruction of, trade and commerce by the blockade would have been prevented. Merely from the monetary standpoint, the saving would have been incalculable; and yet this would have been the smallest part of the gain.

It can therefore be taken for granted that there must be adequate preparation for conflict, if conflict is not to mean disaster. Furthermore, this preparation must take the shape of an efficient fighting navy. We have no foe able to conquer or overrun our territory. Our small army should always be kept in first-class condition, and every attention should be paid to the national guard; but neither on the north nor the south have we neighbors capable of menacing us with invasion, or long resisting a serious effort on our part to invade them. The enemies we may have to face will come from over sea; they may come from Europe, or they may come from Asia. Events move fast in the West; but this generation has been forced to see that they moved even faster in the oldest East. Our interests are as great in the Pacific as in the Atlantic, in the Hawaiian Islands as in the West Indies. Merely for the protection of our own shores we need a great navy, and, what is more, we need it to protect our interests in the islands from which it is possible to command our shores and to protect our commerce on the high seas.

In building this navy we must remember two things: first, that our ships and guns should be the very best of their kind; and second, that no matter how good they are they will be useless unless the man in the conning tower and the man behind the gun are also the best of their kind. It is mere folly to send men to perish because they have arms with which they cannot win. With poor ships, were an Admiral Nelson and Farragut rolled in one, he might be beaten by any first-class fleet, and he surely would be beaten if his opponents were in any degree his equal in skill and courage; but without this skill and courage no perfection of material can avail, and with them very grave shortcomings in equipment may be overcome. The men who command our ships must have as perfect weapons ready to their hands as can be found in the civilized world, and they must be trained to the highest point in using them. They must have skill in handling the ships, skill in tactics, skill in strategy, for ignorant courage cannot avail, but without the courage neither will skill avail. They must have in them the dogged ability to bear punishment; the power and desire to inflict it; the daring, the resolution, the willingness to take risks and incur responsibility which have been possessed by the great captains of all ages, and without which no man can ever hope to stand in the front rank of fighting men.

Tame submission to foreign aggression of any kind is a mean and unworthy thing, but it is even meaner and more unworthy to bluster first and then either submit or else refuse to make those preparations which can alone obviate the necessity for submission. I believe with all my heart in the Monroe Doctrine, and I believe also that the great mass of the American people are loyal to it; but it is worse than idle to announce our adherence to this doctrine and yet to decline to take measures to show that ours is not mere lip-loyalty. We had far better submit to interference by foreign powers with the affairs of this continent than to announce that we will not tolerate such interference and yet refuse to make ready the means by which alone we can prevent it. In public as in private life a bold front tends to insure peace and not strife. If we possess a formidable navy, small is the chance indeed that we shall ever be dragged into a war to uphold the Monroe Doctrine. If we do not possess such a navy, war may be forced on us at any time.

It is certain, then, that we need a first-class navy. It is equally certain that this should not be merely a navy for defense. Our chief harbors should of course be fortified and put in condition to resist the attack of an enemy's fleet; and one of our prime needs is an ample force of torpedo-boats to use primarily for coast defense. But in war the mere defensive never pays and can never result in anything but disaster. It is not enough to parry a blow. The surest way to prevent its repetition is to return it. No master of the prize ring ever fought his way to supremacy by mere dexterity in avoiding punishment. He had to win by inflicting punishment. If the enemy is given the choice of time and place to attack, sooner or later he will do irreparable damage, and if he is at any point beaten back, why after all it is merely a repulse and there are no means of following it up and making it a rout. We cannot rely upon coast protection alone. Forts and heavy land guns and torpedo-boats are indispensable, and the last, on an occasion, may be used for offensive purposes also. But in the present state of naval and military knowledge we must rely mainly, as all great nations always have relied, on the battle-ship, the fighting ship of the line. Gunboats and light cruisers serve an excellent purpose, and we could not do without them. In time of peace they are the police of the seas; in time of war they would do some harrying of commerce and a great deal of scout-

ing and skirmishing, but our main reliance must be on the great armored battle-ships with their heavy guns and shot-proof vitals. In the last resort we must trust to the ships whose business it is to fight and not to run, and who can themselves go to sea and strike at the enemy when they choose, instead of waiting peacefully to receive his blow when and where he deems it best to deliver it. If in the event of war our fleet of battle-ships can destroy the hostile fleet, then our coasts are safe from the menace of serious attack; even a fight that ruined our fleet would probably so shatter the hostile fleet as to do away with all chance of invasion; but if we have no fleet wherewith to meet the enemy on the high seas or to anticipate his stroke by our own, then every city within reach of the tides must spend men and money in preparation for an attack that may not come, but which would cause crushing and irredeemable disaster if it did come.

Still more is it necessary to have a fleet of great battle-ships if we intend to live up to the Monroe Doctrine and to insist upon its observance in the two Americas and the islands on either side of them. If a foreign power, whether in Europe or Asia, should determine to assert its position in those lands wherein we feel that our influence should be supreme, there is but one way in which we can effectively interfere. Diplomacy is utterly useless where there is no force behind it; the diplomat is the servant, not the master, of the soldier. The prosperity of peace, commercial and material prosperity, gives no weight whatever when the clash of arms comes. Even great naked strength is useless if there is no immediate means through which that strength can manifest itself. If we mean to protect the people of the lands who look to us for protection from tyranny and aggression; if we mean to uphold our interests in the teeth of the formidable Old World powers, we can only do it by being ready at any time, if the provocation is sufficient, to meet them on the seas, where the battle for supremacy must be fought. Unless we are prepared so to meet them, let us abandon all talk of devotion to the Monroe Doctrine or to the honor of the American name.

This nation cannot stand still if it is to retain its self-respect and to keep undimmed the honorable traditions inherited from the men who with the sword founded it and by the sword preserved it. We ask that the work of upbuilding the navy and of putting the United States where it should be put among maritime

powers go forward without a break. We ask this not in the interest of war, but in the interest of peace. No nation should ever wage war wantonly, but no nation should ever avoid it at the cost of the loss of national honor. A nation should never fight unless forced to; but it should always be ready to fight. The mere fact that it is ready will generally spare it the necessity of fighting. If this country now had a fleet of twenty battleships, their existence would make it all the more likely that we should not have war. It is very important that we should as a race keep the virile fighting qualities and should be ready to use them at need; but it is not at all important to use them unless there is need. One of the surest ways to attain these qualities is to keep our navy in first-class trim. There never is, and never has been, on our part a desire to use a weapon because of its being well-tempered. There is not the least danger that the possession of a good navy will render this country overbearing towards its neighbors. The direct contrary is the truth.

An unmanly desire to avoid a quarrel is often the surest way to precipitate one, and utter unreadiness to fight is even surer. If at the time of our trouble with Chile six years ago we had not already possessed the nucleus of the new navy we should almost certainly have been forced into fighting, and even as it was, trouble was only averted because of the resolute stand then taken by the President and by the officers of the navy who were on the spot. If at that time the Chileans had been able to get ready the battle-ship which was building for them, a war would almost certainly have followed, for we had no battle-ship to put against it.

If in the future we have war, it will almost certainly come because of some action, or lack of action, on our part in the way of refusing to accept responsibilities at the proper time, or failing to prepare for war when war does not threaten. An ignoble peace is even worse than an unsuccessful war; but an unsuccessful war would leave behind it a legacy of bitter memories which would hurt our national development for a generation to come. It is true that no nation could actually conquer us, owing to our isolated position, but we would be seriously harmed, even materially, by disasters that stopped far short of conquest; and in these matters which are far more important than things material, we could readily be damaged beyond repair. No material loss can

begin to compensate the loss of national self-respect. The damage to our commercial interests by the destruction of one of our coast cities would be as nothing compared to the humiliation which would be felt by every American worthy of the name if we had to submit to such an injury without amply avenging it. It has been finely said that "a gentleman is one who is willing to lay down his life for little things," that is, for those things which seem little to the man who cares only whether shares rise or fall in value, and to the timid doctrinaire who preaches timid peace from his cloistered study.

Much of that which is best and highest in national character is made up of glorious memories and traditions. The fight well fought, the life honorably lived, the death bravely met—these count for more in building a high and fine type of temper in a nation than any possible success in the stock market, than any possible prosperity in commerce or manufactures. A rich banker may be a valuable and useful citizen; but not a thousand rich bankers can leave to the country such a heritage as Farragut left, when, lashed in the rigging of the Hartford, he forged past the forts and over the unseen death below, to try his wooden stem against the iron-clad hull of the great Confederate ram. The people of some given section of our country may be better off because a shrewd and wealthy man has built up therein a great manufacturing business or has extended a line of railroad past its doors, but the whole nation is better, the whole nation is braver, because Cushing pushed his little torpedo-boat through the darkness to sink beside the sinking Albemarle.

Every feat of heroism makes us forever indebted to the man who performed it. All daring and courage, all iron endurance of misfortune, all devotion to the ideal of honor and of the glory of the flag, make for a finer and nobler type of manhood. It is not only those who do and dare and endure that are benefited, but also the countless thousands who are not themselves called upon to face the peril, to show the strength or to win the reward. All of us lift our heads higher because those of our countrymen whose trade it is to meet danger have met it well and bravely. All of us are poorer for every base or ignoble deed by an American, for every instance of selfishness or weakness or folly on the part of the people as a whole. We are all worse off when any of us fails at any point in his duty toward the State in time of

peace or his duty towards the State in time of war. If ever we had to meet defeat at the hands of a foreign foe, or had to submit tamely to wrong or insult, every man among us worthy of the name of American would feel dishonored and debased. On the other hand, the memory of every triumph won by Americans, by just so much helps to make each American nobler and better. Every man among us is more fit to meet the duties and responsibilities of citizenship because of the perils over which in the past the nation has triumphed; because of the blood and sweat and tears, the labor and the anguish, through which, in the days that have gone, our forefathers moved on to triumph. There are higher things in this life than the soft and easy enjoyment of material comfort. It is through strife, or the readiness for strife, that a nation can win greatness. We ask for a great navy, partly because we think that the possession of such a navy is the surest guarantee of peace, and partly because we feel that no national life is worth having if the nation is not willing, when the need shall arise, to stake everything on the supreme arbitrament of war, and to pour out its blood, its treasure and tears like water rather than submit to the loss of honor and renown.

In closing, let me repeat that we ask for a great navy; we ask for an armament fit for the nation's needs, nor primarily to fight, but to avert fighting. Preparedness deters the foe and maintains right by the show of ready might without the use of violence. Peace, like freedom, is not a gift that tarries long in the hands of cowards or of those too feeble or too short-sighted to deserve it, and we ask to be given the means to ensure that honorable peace which alone is worth having.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE CONSOLIDATED MESS OF THE CREW OF THE U. S. S. INDIANA.

By Lieut. BENTON C. DECKER, U. S. Navy.

The consolidated mess has been in operation on the Indiana since May 1st, 1896. The term "consolidated mess" comes from the fact that all the independent messes, with their cooks, caterers and mess funds, are consolidated into one general mess.

The mess, since starting, has had the advantage of the personal interest and assistance of the executive officer. As assistant he had a junior line officer who carried out the details and, later, was given charge of the mess by order of the Bureau of Navigation. Upon the latter's detachment the mess was turned over to the paymaster.

The mess as now organized consists of about three hundred and eighty men, a ship's cook of the 1st class, two of the 2nd class, and four of the 3rd class, a commissary yeoman and a storeroom keeper. Of all the ship's company only the chief petty officers and the officers' servants are excused from joining the mess.

Two of the cooks are stationed in the bakery, the others work at the galley. In addition to the cooks there are messmen, taken from the landsmen, who receive the ration at the galley and serve it to the mess. The messmen are responsible for the mess equipage.

The officer in charge is responsible for the money handled, the paying of bills and the settlement of the ration. The fund for provisioning the mess comes from the commuted rations, one-half of all in the mess, and the canteen. The commissary yeoman looks out for the buying and transporting of the provisions to the ship and has charge of the galley cooks. He also has charge of the canteen.

Every assistance has been rendered to make the mess a success. Cooks have been allowed by the Department, a bake oven supplied, rations commuted, and the ration of hard bread converted to flour. The government ration is issued to the mess in bulk, and handled by it to the best advantage. In general, it is stored for issue at sea, or providing for meals when disappointed by contractor. Canned goods being more expensive than fresh provisions, it is a loss to the mess to issue them in port. In this ship it would be better for the mess, it is thought, if more rations were commuted.

A spare coal bunker on the berth deck has been converted into a storeroom and serving-out stand. The consolidating of the messes renders the subdividing of the cold storage room unnecessary and causes it to serve the crew much more efficiently.

The centralization of the ration for the crew tends to make its distribution more economical. The services of a few trained, well paid cooks ensure the proper preparation of the ration and no waste from badly cooked food.

Under the former system each mess bought its extra provisions in small quantities from a ship chandler that came off to the ship. The time consumed, the expense of transportation, and the small quantities bought, all tended to make the prices high. Under the new system all the advantages of buying in large quantities are gained. The provisioning of four hundred men is a large contract and dealers can afford to give discounts, especially knowing that their pay is certain. Such discounts small messes acting singly could not get. The fact that the contract can be revoked without any of the formalities of a government contract aids in securing the delivery of provisions fully up to the requirements. As a check, the accounts of the officer in charge were audited by the paymaster at the end of each month. All bills have been paid with paymaster's checks.

The opposition to the mess was great at first, and many expressed the opinion that it would be better to return to the old system. But in spite of discouragement and lack of appreciation of the work that was being done, the mess was maintained and prospered. The opposition was soon found to come from two classes, the first class petty officers and the mess cooks. The former felt that they had a grievance in that they were required to eat the same ration as the other members of the crew. Their

pay was sufficient to enable them to pay a large mess assessment, and the quality of their fare was reduced some. As for the mess cooks they no longer received all the perquisites of the berth deck cook of former days, and naturally opposed the plan. The opposition of the petty officers was shown in complaints at the mast regarding the quality and quantity of the ration; that of the cooks in the spoiling and wasting of the food, and in lack of care in serving the ration to the members of the mess, so that some went hungry and others were surfeited. As time passed the opposition weakened and has now apparently died out. New men joining the ship from time to time saw the advantages of the new mess and convinced their messmates that they were well off. Such words as the following, from a petty officer, have weight: "I never lived better." "The month before coming to the ship two caterers ran away with the mess money and we had to pay an extra assessment." Here he lived better without any assessment. There was opposition from the firemen on the ground that the ration was not substantial enough, and too little of it. This was remedied on later passages by giving them beans and coffee when they went on a mid or morning watch. This the mess could afford to do. Needless to say the trouble ended.

At the time the mess was organized a canteen was started for the selling of beer. By doing this, all the profits went toward bettering the food that could be furnished, the quality of the beer could be assured, the quantity consumed regulated, and the price maintained uniform, allowing a reasonable profit. The profits went, in part, to make a reserve fund against the time when it would be necessary to lay in sea stores. During the time the canteen has been running the profits have been about $3000. There is now on hand a reserve fund of about $2000. From now on the profits of the canteen can be devoted to raising the quality of the food and providing for extra occasions, such as Christmas.

It has been stated that the mess could not be maintained on foreign stations, at sea, or in ports where food supplies cost more than in the markets of the large cities of our own country. The advantages of the cooking being done by capable cooks, the economy of handling the entire ration, government or special, and the bakery supplying fresh bread every day, cannot be lost. It is thought that it would be impossible to secure these advantages where there are separate messes.

In regard to the mess gear, the Department has supplied this to the ship. The consolidated mess took this mess gear and deposited the money value with the paymaster, relieving the executive officer of any care in the matter.

The attempt has been made to show briefly the important features of the system, its present financial prosperity, and the trials that attended its introduction. A great amount of patience and perseverance has been required, as was to be expected from the breaking up of time-honored customs, and the known opposition of "Jackey" to any encroachment on what he considers his rights.

The chief advantage of the system is thought to be that the men are constantly provided with a wholesome, steady diet. There will no longer be caterers running off with the mess money and the mess living on "hard bread and coffee." Mess money cannot be devoted to betting on boat races. Poor landsmen, in debt, are no longer seen at the mast begging for a few dollars to put in the mess. The indigestible messes served up by ignorant landsmen are no longer seen. The money paid cooks formerly is now saved to the men, the only cooks that are allowed extra compensation being the galley cooks; the chief cook receiving one ration and the others, each, half a ration. There is no longer the trouble between messes as to the stowing of sea stores and the finding of them in every stowhole. In landing drill the advantage of the system would be further shown. During the past summer the men from the Indiana were supplied with a substantial ration of sandwiches, sardines, and hot coffee, without any inconvenience.

The ration is an excellent one. Each day the government ration of fresh meat and eighteen ounces of fresh bread is allowed.

The following bill of fare was taken indiscriminately:

Breakfast: eggs, liver and bacon, coffee, bread and butter.

Dinner: fresh corn beef and cabbage, potatoes, new onions and radishes, coffee, bread and butter.

Supper: chicken stew, tea, bread and butter—condensed milk and sugar being supplied for the coffee and tea.

The following is a sample of the usual Sunday dinner: roast pork, jelly, fresh green peas, new potatoes, pie.

The foregoing shows what can be done in a good market. Of

course this could not be maintained where food was more expensive.

It is the expressed opinion of officers of this ship that the consolidated mess is a success. All the advantages attendant upon the better feeding of men must follow upon the successful running of such a mess.

(*Discussion at end of number.*)

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE SAILOR IN THE REVOLUTION.*

By Commander C. F. GOODRICH, U. S. Navy.

It is not my purpose to recount in detail the naval episodes of the War of the American Revolution, although all are interesting and many thrilling. This work has been too often done by abler hands than mine to call for, or to admit of, repetition. The pages of Jas. Fenimore Cooper, for example, are a guide to these events whose trustworthiness is beyond question and above praise.

In reading the history of this struggle, great in itself and greater still in its consequences to mankind, having in view the obtaining of lessons appropriate to our present needs, I have been much impressed by the absence of those broad generalizations which, alone, bring benefit to the student, illuminating his path with the lamp of experience. The lamp has always been burning, giving forth its rays in every direction with lavish generosity; but, as far as I am aware, there has been lacking that accurate synthesis which, placing the facts in their true relation to each other, should serve as a lens to bring the rays of light together into one powerful and searching beam. I cannot pretend to have found this lens myself, but, at least, certain deductions from these events have suggested themselves to me as worthy of consideration, if not of acceptance, and to them I ask your attention for a brief time.

The war in question was a naval war to an extent seldom fully realized and never generally acknowledged. That the war

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would assume this phase might have been expected on *à priori* grounds. England was waging hostilities at a distance of some three thousand miles from home. For the maintenance of communication between her troops in America and their base in Great Britain, the command of the sea was an imperative necessity. Let that be lost and her armies in the colonies would infallibly perish; for military stores were not to be had in the theatre of operations, and other supplies were often difficult to obtain in the midst of a population for the greater part intensely inimical. Again, the colonists, settled principally along the seaboard, had been engaged in maritime pursuits to a degree which, proportionally, has not been surpassed in our history. As fishermen and sailors their numbers were relatively vast. Their enterprise and skill brought, indeed, so serious a menace to England's commercial supremacy on the water that among their grievances were measures which sought to restrict this energetic competition with the mother country. As a natural sequence, these men of nautical bent and experience found an appropriate field for activity in attacks on British transports and British merchantmen, provoking, in return, a large display of British naval force. The numbers engaged in these operations afloat were so much greater than those under arms ashore that the latter appear, by comparison, almost insignificant.

In actual organized collision between the King's forces and the colonists, the first blood was shed on the water in the *Gaspee* incident of 1772. It was also a naval movement that brought the war to a close, for without the help of the French fleet Washington and Lafayette could not have compelled the surrender of Cornwallis, the last important scene in the military drama. Surely these facts justify our looking at this war from the naval standpoint and absolve me from the need of further apology for inviting you to listen once more to a twice-told tale.

The occasion of the *Gaspee* episode was the attempted enforcement of the odious Navigation Act by British armed vessels, charged with the duty of seeing that all colonial craft were provided with the stamps made requisite under the law. On June 9th, 1772, the *Hannah*, Captain Linzee, a packet plying between New York and Providence, refused to come for examination alongside a British cruiser in Narragansett Bay, but, profiting by a fresh and favoring breeze, she ran off and stood up the bay.

The sloop *Gaspee*, of 102 tons, a small armed tender to the cruiser, mounting four or six 3-pdrs., was signaled to chase. Capt. Linzee, familiar with the local navigation, led the *Gaspee* over a shoal where, drawing more water than the *Hannah*, the former struck, while the latter escaped to Providence. Capt. Linzee's account of the matter so incensed the inhabitants of that town that they planned and fitted out an expedition to avenge the fancied outrage. Sixty-four men, disguised as Indians and led, it is believed, by Captain Abraham Whipple, later one of the first captains to be commissioned in the United States Navy, dropped down the river that night in eight boats, provided mainly with cobble-stones as missiles. At 2 a. m. they reached the stranded *Gaspee*. They were hailed by the sentry, who received a volley of stones in reply. He rushed below to rouse his mates. Lieutenant Dudingstone, in command, came on deck and fired a pistol at the boats. He was wounded in the thigh by a musket-ball discharged in return. The *Gaspee* was carried by boarding, and Dudingstone was further injured by a sabre cut that nearly severed his right hand from the wrist. The Gaspee's people were removed and the vessel set on fire. Towards morning she blew up. A reward of a thousand pounds sterling for the leader and one of five hundred pounds for any of the others in this party were offered in vain by the British government. Nor were the labors of a royal commission that sat from January till June of the following year, attended by better results. The loyalty of the colonists to each other was proof against all temptation. The affair may, with propriety, be deemed the opening act of hostilities between England and her American possessions. Preceding Lexington by nearly three years, it has been lost sight of in the latter's greater renown—a renown based upon the larger numbers engaged, upon a notable loss of life on both sides, and upon the stirring events to which it was the immediate prelude. I have thought it not improper to describe the taking of the *Gaspee* at some length, and to claim for the enterprise its due place in the order of events.

From a military point of view, the position of England on the continent of North America from 1775 to 1782 was alternately offensive and defensive; offensive so long as her command of the sea was practically unchallenged or undisturbed, defensive the moment her communications were seriously threatened or

were interrupted. It is these varying phases, presented by the military situation, which so complicate the general question and render difficult a right understanding of the British campaign as a whole. Yet it is evident that just so long as she could safely play the part of aggressor her advance was, on the whole, not measurably checked. When her sea communications were endangered, the movements of her troops became retrograde at once. Thus in 1776 the continued interception of its supplies by American cruisers was of little if any less weight in forcing the British army to evacuate Boston than the increasing pressure of the besieging Americans. Again, in 1778, it was not Washington's army, but the sailing of d'Estaing's fleet from Toulon that drove Clinton out of Philadelphia and back upon his local base in New York.

A year later the mere news that d'Estaing was coming to America was sufficient to cause the precipitate abandonment of Rhode Island by the British.

Arguing from these facts, it becomes at least conceivable that measures directed towards naval control of the coast on our part might have materially shortened the war.

The steps taken by the colonists to prosecute hostilities on the water reflected the lack of organization existing at the seat of the new government. There were privateers, cruisers equipped by individual colonies, and national cruisers. These vessels acted in concert or independently, according to circumstances. Similarly, officers of the regular navy are found serving in each class, passing from one to the other as occasion demanded. A distressing absence of homogeneity is noticeable throughout all the American operations. If the word were permissible, amateurish would appear to be that best adapted to characterize them. Let us review briefly the services performed by each of the above-mentioned varieties of ships.

The old and ever new *ignis fatuus* of commerce-destroying shed its baleful light over the colonists, luring them on to a false policy. As a subordinate adjunct, prosecuted with a surplus of ships and men, and so controlled as to help and not hinder regular hostilities, commerce-destroying is always useful, while, at times, important. But when, as in the War of the American Revolution, it cripples the crews of national vessels, and through frequent capture by the enemy followed by non-exchange of

prisoners, it gradually decimates the seafaring population; when it assumes a magnitude out of all proportion to the more capital operations of the marine, it becomes an evil but slightly, if at all, mitigated by the distress inflicted on the foe. Wars are brought to a conclusion by the defeat of armies and squadrons, not by guerillas, however successful, either afloat or ashore. The damage done to our commerce by the Confederate cruisers in the War of the Rebellion, vast as it was, had absolutely no effect on the issue of the contest. This lesson has never been learned by our people, yet it is as true to-day as it was thirty-five or even one hundred and twenty years ago.

Hutchinson in his diary states his belief that seventy thousand New Englanders were engaged in privateering at one time. According to Edward Everett Hale, the privateer fleet of the port of Salem, in 1781, consisted of fifty-nine vessels, which carried nearly four thousand men, averaging sixty-six men to the ship, and mounted seven hundred and forty-six guns. There seems to be no means of making an exact computation of the magnitude of the privateer fleet at any one moment, but a partial list in the Massachusetts Archives of those commissioned in that State gives the names of two hundred and seventy vessels. The privateer fleets from Rhode Island, Connecticut and Philadelphia were also large. Salem is known to have sent out one hundred and fifty privateers and Boston three hundred and sixty-five. It would probably be fair to say that during the war more than six hundred privateers were commissioned by Massachusetts alone. "The largest of these privateers," says Mr. Hale,* "at starting carried one hundred and fifty men. With each prize sent in the fighting force of the captor was reduced, and in such reduction is the reason to be found why at last a privateer captain was not able to fight his own ship and, after he had sent in many prizes, was himself taken. On the other hand, the smallest of these vessels, equipped for short cruises, carried but few guns and few men."

I have been unable to gather statistics as to the number of privateers sailing from the Delaware, from Southern waters or from France.

That an amount of injury commensurate with this display of force was dealt to English transports and merchantmen is con-

*E. E. Hale, in Crit. and Narr. Hist. America.

ceded. Almon's Remembrancer records three hundred and forty-two sail of English vessels taken by American cruisers of all kinds in 1776. In the following year, four hundred and sixty-seven were captured, some of them of great value. In the single month of May, 1779, eighteen prizes were brought into the port of New London. In 1780, the Admiralty court of the Essex district of Massachusetts had condemned eight hundred and eighteen prizes. Of this period Cooper says, "Many American privateers fell into their [British] hands, and a scarcity of men began to be felt in consequence of the numbers that were detained in English prisons."

Not the least of the bad results of privateering on such a large scale was the difficulty of obtaining crews for the national ships, the naval service holding out fewer and less specious attractions to recruits than did the privateer with its short trips, lax discipline and chances of greater gain. This difficulty, by the way, is likely to recur with a renewal of the conditions which gave it birth.

The privateers were an excellent school of seamanship and battle. It would ill become us at this day to withhold our tribute of praise for their brave deeds, however much we may regret the misapplication of their valuable powers.

Such achievements as the surrender of the *Governor Tryon*, 16, and the *Sir Wm. Erskine*, 18, to the American privateer *Thorn*, 16, Captain Daniel Waters, should not be forgotten. True, the *Tryon* managed to escape while Waters was securing the *Erskine*, but this mishap was partially repaired a few days later, when on his way to Boston he captured the *Sparlin*, 13, bringing in the two prizes which he had apparently set his heart upon taking. In like manner Captain Manly of the *Jason*—probably of 20 guns—being attacked by two English privateers, one of 16 and the other of 18 guns, boldly ran between them and captured them both. Nor is the action on September 6th, 1781, between the *Congress*, 20, Captain Geddes, and H. B. M. sloop-of-war *Savage*, 16, Captain Sterling, less notable. The heavier ship won the fight, but she had to contend against the man-of-war's superior drill and discipline consequent upon an already long commission. The privateer's crew were raw and untrained, the vessel being just out of port. An aptitude for such work combined with zeal and intrepidity to make their superior weight of metal effective. Our time is too limited to recall other equally gallant encounters

in which American privateers gained honorable laurels, even if they came fairly within the scope of this study.

The colonial navies were not insignificant in numbers at least, though many of the vessels under this head were small and weak. The navy of Massachusetts comprised thirty-four craft from the beginning to the end of the war. As early as February 16th, 1776, South Carolina had a ship of 26 guns, a brig of 18 guns and a schooner of 12 guns. Others were added later. Among them was the *South Carolina*, borrowed from the King of France, much the heaviest ship that ever sailed under the American flag until the frigates of 1794 were built. Connecticut, Rhode Island and Pennsylvania also commissioned armed vessels. Virginia's navy appears to have consisted of small light-draught boats suitable for operating in the waters tributary to Chesapeake Bay. Beatson mentions the scuttling or burning in the James River in March, 1781, of the *Tempest*, 20, *Renown*, 26, and *Jefferson*, 14, "State ships." These probably belonged to Virginia. I am not able to give numbers with any possible approach to accuracy, but it may be assumed that not less than sixty were in active service at one time or another.

The work of these colonial cruisers was only less important than that of the national vessels. The former generally acted singly, in this respect differing from the latter, which not infrequently sailed in groups. Indeed, the naval operations of the war were begun by the little schooner *Lee*, belonging to Massachusetts, under the command of John Manly, whose later success in the *Jason* has been already mentioned. The *Lee* was the first vessel of any kind to sail with authority to cruise on behalf of the entire republic. Her capture on November 29th, 1775, of the British brig *Nancy*, laden with military stores for General Gage, brought sorely needed supplies to the Colonial troops about Boston. The following June she was helped out of a serious scrape by the only less famous Connecticut brig *Defence*. The two, aided by three privateer schooners, reversed the condition of affairs and captured two armed transports filled with troops which had just proved too heavy for the schooners alone. Captain John Foster Williams seems to have earned more than one man's share of glory, for he not only captured H. B. M. S. *Active*, 18, while in command of the Massachusetts cruiser *Hazard*, 14, in 1779, but shortly afterwards in the *Protector*,

belonging to the same State, he fought a large letter-of-marque, the *Duff*, said to have been of equal force. The *Duff* blew up in the action. On her way home the *Protector* had a sharp running fight with the frigate *Thames*, 32, and escaped through skillfully crippling the *Thames* aloft by her well-aimed fire. The action between the Pennsylvania cruiser *Hyder Ally*, 16, and H. B. M. S. *General Monk*, 18, which occurred in the mouth of the Delaware in March, 1782, was one of the most brilliant single-ship engagements of which we have any account. Captain Barney well deserves the glory with which song and story invest him as the hero of this dramatic event for his skill and bravery in compelling success against a superior force within sight of a British frigate and a British privateer brig.

As to the national cruisers, history is somewhat more explicit, although doubts arise in certain cases touching the identity of individual vessels, the readiness with which a ship or an officer passed into or out of the general service obscuring the record.

The first effort at securing a navy bears date of October 13th, 1775, when Congress passed a law ordering one vessel of 10 guns and another of 14 guns, to be equipped and sent on a cruise to the eastward to intercept royal supplies. Two months later it directed the construction of thirteen ships, three of 24 guns, five of 28 guns and five of 32 guns. Of these the *Raleigh*, *Boston* and *Montgomery* bore names still to be found on our navy register, from which those of the *Warren*, *Congress* and *Delaware* have but comparatively recently been erased. On October 3, 1776, it authorized another frigate and two cutters, and on November 9, 1776, three 74s, five more frigates, one sloop-of-war and a packet. The need of heavy ships was beginning to be perceived, at least in theory. Practically but one 74, the *America*, was laid down, and she was presented to France the day of her launching in 1782 to replace the *Magnanime* of de Vandreuil's squadron, lost while attempting to enter Boston harbor. On the 22d of December, 1775, Congress appointed Esek Hopkins of Rhode Island, commander-in-chief, four captains, each by name, to the purchased vessels, *Alfred*, *Columbus*, *Andrea Doria* and *Cabot*, together with thirteen lieutenants. Of the latter, John Paul Jones was senior.

The *Hornet*, 10, sloop, and the *Wasp*, 8, schooner, were the first regular cruisers to get to sea. As time went on, others were

purchased or borrowed or hired. Thus in October, 1776, the list comprised the thirteen building under the act of December, 1775, besides thirteen more otherwise acquired. From the beginning to the end of the war the United States had forty-one vessels in commission, including the *Bonhomme Richard* and her four Franco-American consorts. Some of these never got to sea.

Cooper says of the vessels of the act of 1775: "The ships ordered were large enough to resist the small cruisers of the crown, and were well adapted to destroy convoys and to capture transports and store-ships. . . . Most of the ships mentioned . . . were armed with nines and twelves, having sixes, or even fours, on their quarterdecks and forecastles. It is thought that there were no eighteen-pounder frigates constructed under the laws of 1775." You will perceive that of the necessity for ships for purely military purposes there seems to have been no conception except as embodied in the three 74's that never materialized. Commerce-destroying and the intercepting of supplies seem, as is our custom, to have controlled the building programme. The fate experienced by the majority of these vessels was abundantly foreshadowed in their light scantling and Fourth of July batteries.

On the British side we see on our coast a rough average of 26,000 sailors in seventy or more vessels of various sizes. Thus Lord Howe had six 64's and three 50's at New York in 1778 before Byron's fleet, which counted 74's among its number, arrived to reinforce him. Howe's ships alone were an easy match for all we could possibly gather under one command.

The comparison by numbers, both of ships and men, employed by the two contestants is greatly in favor of the Americans, but they never had afloat a single vessel able to challenge the British 64's, or even 50's, while the advantages of organization, discipline, *esprit de corps* and service traditions lay wholly with their enemies. Too often, indeed, our crews were made up in part of British prisoners, who in return for their release agreed to serve in our navy. The mutiny on board the *Alliance* in 1779 would doubtless have succeeded but for its timely detection. It was planned by the released British seamen in the crew. The loss of the U. S. S. *Trumbull*, 24, in 1781 was largely due to the presence in her ship's company of "these questionable materials," to use Cooper's expression, to the extent of more than one-fourth of a

scant 200. These men so influenced their comrades that in the confusion of the damage occasioned by a sudden squall and in the darkness of the night the captain could not muster fifty of his men to fight the *Iris*, 32, and *General Monk*, 18. The battle might also be said to have been fought by the officers.

It followed, inevitably as night follows day, with ships often hastily improvised, badly manned, poorly equipped, heterogeneous in type and handled without unity of purpose or clear notions of strategy, that there was a corresponding waste of energy and barrenness of result. Individual acts of brilliant seamanship and great gallantry abound. What could have been finer than Nicholas Biddle's behavior in the *Randolph*, 32, when, finding he had engaged, not an armed merchantman as he supposed the *Yarmouth*, 64, he pluckily fought his great antagonist until his own ship blew up? To mention John Paul Jones and the *Bonhomme Richard* is to recall to mind one of the most extraordinary and stubbornly contested naval battles recorded in history. Indeed, with scarcely an exception, the American flag was flown with such credit and defended with such vigor as to compel our adversaries to acknowledge that with equal ships their chances of victory were no greater than ours. I know of no better specific for a relaxed condition of patriotism than the reading of the glowing pages of Cooper which describe these exploits. But ours is a different task. Let us contrive, if possible, to obtain a general view of the naval campaign.

In the early part of 1776 the Commander-in-Chief, Esek Hopkins, with a force consisting of the purchased vessels *Alfred*, 24, *Columbus*, 20, *Doria*, 14, *Cabot*, 14, *Providence*, 12, *Hornet*, 10, *Wasp*, 8, and *Fly*, despatch, left the Delaware under instructions to proceed to the southward with a view to act against the naval force, which, under Lord Dunmore, was then ravaging the coast of Virginia. Instead of executing his orders, Hopkins made a descent on New Providence, in the Bahamas, where he captured a number of cannon and other military stores. For his failure to do as directed and for his mishap in engaging without result the *Glasgow*, 20, on his way home, Hopkins was eventually dismissed the service. In this case it was the naval commander who misapprehended the right use to make of a fleet, viz., for the destruction of the enemy's armed force.

The navy of the United States after this miscarriage, with but

rare exceptions, was employed in disconnected cruises against British commerce and British transports. It deliberately declined the purely military rôle for which its weakness ill adapted it, and sought by desultory raids to compensate for its lack of strength. When a favorable opportunity offered, it did not hesitate to engage the enemy on even terms, but these opportunities were not so much by choice as by hazard. The prizes captured were often a welcome, if intermittent, source of revenue. This is especially true of those taken in European waters by such craft as the *Surprise* and *Revenge* under Conyngham and the *Bonhomme Richard* and her mates under Jones, all fitted out by the American commissioners in France. That British trade was hampered, not to say demoralized, is abundantly proved by contemporaneous reports (the government was even obliged to furnish convoys for the Irish coast trade), but unless the high rates of marine insurance and the alarm of the mercantile community can be shown to have exerted a determining influence upon the conclusion of hostilities, it is yet open to question whether all these depredations had a direct military value at all comparable with the operations of a squadron of good vessels sailing with a correct strategic purpose.

The progress of the war was, naturally, marked by a steady decrease of our forces and as notable an increase of the British ships employed on our coast. Thus in 1776 we counted twenty-five vessels and four hundred and twenty-two guns to the enemy's seventy-eight and two thousand and seventy-eight respectively. Two years later we had but fourteen ships and three hundred and thirty-two guns; the English, eighty-nine ships and two thousand five hundred and seventy-six guns. Yet, in the meantime, the thirteen frigates and sloops authorized in 1775 had been built, launched and commissioned. The official list sent to Franklin in March, 1780, of the navy of the United States at that time comprises besides the *America*, 74, *Bourbon*, 36, and *Saratoga*, 18, on the stocks, only eight vessels mounting 222 guns. The enemy's command of the sea occasioned the loss of those members of this batch that were constructed in the Hudson and Delaware, with hardly a struggle on our part. When the British in 1777 moved into Philadelphia they first bottled up, then afterwards destroyed or captured the *Washington*, 32, *Effingham*, 28, *Delaware*, 24, *Andrea Doria*, 14, *Sachem*, 10, *Wasp*, 8, *Inde-*

pendence, 10, *Dolphin*, 10, a heartrending showing truly, and the most extensive disaster to which our little marine was ever subjected. The vessels built in New England were much more fortunate, all getting to sea with useful and honorable careers. The British investment was less strict off the Eastern coast than at New York and Philadelphia. One is unable to escape the regret that more ships and heavier were not laid down at Portsmouth, Salisbury, Providence, Mystic, and elsewhere in Massachusetts, Rhode Island and Connecticut.

The British naval operations were confined principally to guarding the over-sea communications and to containing, as military men say, the French squadron in Newport after the formation of the alliance. They were usually characterized by a want of energy, which is in striking contrast with the bold and masterful movements of England's later fleets under St. Vincent and Nelson. Lord Howe rose superior to the emergency of 1778, when d'Estaing arrived off Sandy Hook, but this instance of skill and vigor did not redeem a generally weak policy. For our part we could not have asked for poorer men in command of the British fleet than Howe's successors, Arbuthnot and Graves. It seems incredible that so careless a watch should have been kept over the harbors of New England with their potent menace in ships, sailors and shipbuilding facilities. In this neighborhood ingress and egress seem to have been only less free than in times of peace. We wonder whether this could have been the same navy which twenty years afterwards held Brest, Lorient, Rochefort, and indeed the whole coast of France in the relentless grip of a blockade which remains to this day the model of what such a measure ought to be.

The number of seamen voted by Parliament for the year 1775 was 18,000, but the figures rose by leaps and bounds as the war progressed until it reached the astonishing development of 90,000 in 1781.

When Vice-Admiral Samuel Graves arrived at Boston in June, 1774, to take command of the British naval forces on our coast, he found there no less than seventeen ships and vessels exclusive of his flagship, the *Preston*, and three divisions of transports.*

* Samuel Graves is not to be confounded with Thomas Graves who, seven years afterwards, was unfortunate enough to fail in his attempt to keep De Grasse out of the Chesapeake. The former was as energetic as the latter was incapable.

Beatson says, vol. IV, p. 47: "When Admiral Graves was under a necessity of recalling some of his cruisers, the better to block up the port of Boston, in terms of the act of Parliament, the Americans availed themselves of the weakness of the squadron and procured supplies to an astonishing degree; so that it required more ships than the Admiral could spare to carry the Boston Port Act into execution."

It was to this locality that the early activity of the British fleet was mainly confined. Besides the interception of ammunition and other stores, Graves took a prominent share in the military operations during the siege of Boston by the Continentals, covering with the *Somerset*, 64, the retreat through Charlestown from Lexington, guarding with his ships and boats the principal waterways, defending the British hay and cattle on the different islands in the harbor from destruction and raiding by the Americans, and especially lending valuable assistance on the day of Bunker Hill.

"The *Lively*, *Falcon* and *Spitfire* (on that occasion) anchored abreast of and below Charlestown, covered the landing of the troops and kept up a well-directed fire, as long as they could distress the enemy, without too much endangering their own people." (Beatson, IV, 76.)

During the fight the ships threw red-hot shot into Charlestown and burnt the town.

It was during the autumn of this year that Falmouth (now Portland) in Maine was burnt by a detachment under Mouat sent out by Graves in the ship *Canceaux*, the schooner *Halifax*, the sloop *Spitfire*, each mounting 6 guns, and the 18-gun armed transport *Symmetry*. What is not so generally known is that this was but one of a series of similar measures contemplated. Gloucester, Beverly, Marblehead, Salem, Newburyport, Portsmouth, Ipswich, Saco and Machias were ordered to be dealt with in this same brutal manner and in the order named. The wind prevented the British from reaching those highest on the list, so that the first blow fell in Maine. The outrages so aroused the whole coast that Mouat, the commander of the expedition, unable to go elsewhere, returned to Boston.

On the shores of Virginia Lord Dunmore was playing a similar part. He and Mouat appear to have been worthy apostles of the doctrine of harrying and ravaging with which Benedict

Arnold, after his treason, is most particularly identified. Well may the British chronicler write (Beatson, IV, p. 99): ". . . . the progress which hostilities had now made, aggravated by the occurrences of a predatory war, had inflamed the vindictive passions and carried both parties beyond the bounds of reconciliation."

In the meantime, through the vigorous and incessant intercepting of British transports and supply vessels by American cruisers and privateers, together with the wiser strategy attending Washington's assumption of general command on shore, the British garrison and fleet in Boston found themselves in a position which may, with moderation of expression, be termed precarious. On the 17th of March, 1776, the town was evacuated and Rear-Admiral Shuldham, Graves' successor, escorted and conveyed General Howe to Halifax, whence three months later they sailed for New York.

In the movements that eventuated in New York's falling into their hands, the British navy took a full, eager and creditable share.

With the exception of what, for want of a better term, may be vaguely called blockading duty, the British navy seems to have acted largely as an auxiliary to the army until the advent of the French squadrons. It is needless to enter into the details of the numberless minor joint enterprises that were undertaken. The raiding and burning of towns along the Sound in particular and the coast in general may be recalled in illustration.

The habitual monotony of the British operations was broken on several occasions. In June, 1776, Sir Peter Parker made his attempt on Charleston, wherein he proved, for the hundredth time, the inferiority of ships to forts under ordinary conditions of direct attack, and wherein Moultrie and his palmetto logs won the lion's share of glory. The reverse had no appreciable effect on the general course of the campaign, for it merely put a stop to a movement which Lord Cornwallis subsequently demonstrated to be strategically unsound. In December of the same year Newport was occupied by Clinton under escort of Sir Peter Parker in a small squadron of frigates.

When the British army moved on Philadelphia in 1777 a portion of the fleet, now under Lord Howe, aided in its transportation to the head of the Chesapeake, while another portion

ascended the Delaware, to be followed shortly by Lord Howe in person. The fortifications and obstructions in the river below Philadelphia were reduced and overcome at the price of considerable loss in ships and men—a loss that was more than counterbalanced by our own disasters, elsewhere mentioned.

How seriously was regarded the naval task assumed by England on our coast is shown in the statement at this time by the First Lord of the Admiralty that "in America there were ninety-three ships and vessels of war, of which six were of the line" (Beatson, IV, 291). It naturally suggests itself that the all-important purpose of cutting off the colonies from their source of warlike supplies abroad would have been better served had fewer of these ninety-three vessels been employed as an adjunct to the British army and more set to guard the approaches to our ports. That the British naval force was misused was Washington's firm opinion, confirmed by an episode immediately following the arrival in Newport of the French squadron under de Ternay.

Eighteen years after this time Nelson, at the battle of the Nile, demonstrated the entire practicability of crushing a fleet at anchor by the rapid and well conceived attack of another fleet under way and entering the roadstead from the sea. A similar opportunity was enjoyed by Admirals Graves and Arbuthnot in 1780. De Ternay lay in Narragansett Bay with the *Duc de Bourgoyne*, 80, the *Neptune* and *Conquérant*, 74's, the *Provídence*, *Eveillé*, *Jason* and *Ardent*, 64's, seven ships of the line and two frigates, the *Surveillante* and *Amazone*. The English admiral appeared off the port on the 21st of July with eleven ships of the line, one of 90 guns, six of 74, three of 64 and one of 50, a force ample to overcome the French vessels had their commanders possessed the energy of Nelson. Besides this possible and most desirable result was the strong military necessity of dealing with Rochambeau before he could effect a junction with Washington, to which end Sir Henry Clinton had embarked a large body of troops in transports at Throg's Neck in the Sound. Unable to make up their minds to risk the passage into Narragansett Bay, Graves and Arbuthnot turned back. Clinton now found how intimate was the connection between the integrity of his over-sea communications and the operations on shore, for Washington had profited by his absence from the city to make a threatening demonstration on New York.

In 1780 a second combined expedition against Charleston resulted more favorably to the enemy. The town was reduced after a long siege, and our navy lost the *Providence*, 28, the *Queen of France*, 28, the *Boston*, 24, the *Ranger*, 18, together with several small vessels.

On the American side the only instance of strategic use of sea power is found in the Penobscot affair, where we failed miserably through neglect of tactical precautions. As this ill-fated attempt illustrates, to an exceptional degree, certain principles of coast defense, it is proper to recite briefly the initial situation and the succeeding events.

The enemy possessed, near what is now known as Castine, a local base for operations in Massachusetts Bay. This post was fairly well fortified and garrisoned. The State of Massachusetts determining to break it up, organized in 1779 a land force of some 1500 men under General Lovell, also a fleet of three colony cruisers and thirteen privateers. To these were added three United States vessels under Captain Dudley Saltonstall. Allen, in his Battles of the British Navy, gives the following as the list of American vessels present at Castine: Eleven ships, viz. one 32-gun frigate, one ship, 22 guns, six of 20 guns, three of 18 guns; seven brigs, one of 18 guns, one of 16, four of 14, and one of 12, together with nineteen transports. After much delay the works were assaulted, but not taken. Reinforcements were sent for. Pending their arrival, Sir George Collier appeared in the offing with the *Rainbow*, 44, *Raisonnable*, 64, *Blonde*, 32, *Virginia*, 32, *Greyhound*, 20, *Camille*, 20, *Galatea*, 20, and *Otter*, 10. A precipitate flight on our side ensued up the river. The *Warren*, 32, *Diligent*, 14, and *Providence*, 12, were run ashore and burned to prevent their falling into the hands of the enemy. The colonial cruisers and privateers either shared the same fate or were captured. The sailors and soldiers that escaped made their toilsome way back to the settlements through the wilderness of Maine after prolonged and severe suffering.

The object of this expedition was in all ways laudable. The existence of such a secondary base within easy reach of our shores was a serious standing threat to our operations as well as a convenient *point d'appui* for the enemy. To destroy such a base and to remove the attending threat were objects that justified the attempt, provided the defense could be assured of either one

of two things: the command of the sea or a strong harbor of refuge close at hand. By the terms of the case the former condition was absent, the enemy being stronger afloat than we were. The latter condition might have been secured after the expedition had successfully made the dash across from Boston. On the other side of the Penobscot River was an excellent anchorage, sheltered behind an island with two entrances, both capable of defense. I may remark that such refuges are indispensable for the weaker fleet in all coast operations. Had Saltonstall devoted a few of the days lost in idle discussion and waiting to making his ships safe in the not improbable event of Collier's arrival, the attack could have been delivered with the comforting reflection that interruption would not, of necessity, imply ruin. It does not seem that the panic manifested by the American naval commander was at all warranted, nor that some show of resistance was not obligatory in view of the very respectable force he had in hand, as exhibited in Allen's list, quoted above. Assuming, for the sake of argument, that Saltonstall's flight was a necessity through the sudden appearance of superior force, all the greater was his duty to provide a suitable refuge. It was this defiance of the dictates of tactics which brought such a crushing blow to our already slender naval power.

Three months before Washington had expressed his views on the subject of this contemplated expedition. They exhibited a sagacity bordering on prescience. Writing to the President of Congress on April 17, 1780, he said: "Circumstanced as we are, I do not see how the attempt can be made with any prospect of success. A naval co-operation seems to be absolutely necessary, and for this we do not possess the means. We have no fleet, and the enemy has a respectable one on the coast, which they can at any moment employ to frustrate our measures. . . . The operating force, I am informed, must depend on supplies of every kind by water. This communication would be liable to be interrupted at the pleasure of the enemy and the situation of the troops would be alarmingly precarious. . . . Indeed, considering the position of these States, a fleet is essential to our system of defenses, and that we have not hitherto suffered more than we have for want of it is to be ascribed to the feeble and injudicious manner in which the enemy have applied the means in their hands during this war" (Sparks' Writings of Washington, vol. VII, p. 21).

The error committed by Congress in not providing for a navy competent to wage serious war was, in a degree, repaired by the fortunate alliance with France, through which we obtained the presence of a French fleet in our waters and of French troops on our soil. Not having done for ourselves what should have been done, if humanly possible, we were obliged to find friends ready and willing to help us. On February 6, 1778, was concluded a treaty of commerce between France and the United States of America, together with a second and secret treaty in which the contracting parties agreed to unite their efforts against their common enemy, England. The news of the open treaty—a recognition of the independence of the colonies—was followed by the recall of the British ambassador at Paris and the outbreak of hostilities. On April 13, 1778, Count d'Estaing sailed from Toulon for America with eleven ships of the line, one of 50 guns, and five frigates. The English at this moment had six 64's and six 50's on our coast, nine of them being at the mouth of the Delaware under the Commander-in-Chief Lord Howe. It was hoped and expected that Howe would be overpowered before he could be relieved. D'Estaing was ordered to attack the English wherever he could do so with advantage. Should Howe be so much strengthened as to possess the superiority, the French fleet was to retire on Boston and thence proceed to the West Indies. D'Estaing spent so unconscionable a time on the passage that Howe was able, after receiving intelligence of the sailing of the Toulon fleet, to take on board the heavy stores and siege train of Clinton's army at Philadelphia, to consume ten days in getting out of the Delaware, hampered by calms, to reach New York, land his soldiers and their impedimenta, station his vessels in the main channel and erect works on shore for defense, before his rival appeared in the offing. D'Estaing touched at Cape May on July 8th, three days after Howe had transported the army from Navesink to the city. He then proceeded to the entrance of New York. A little more celerity on his part and the British fleet would have been caught on the Jersey coast. As it was, the pilots declared the water insufficient for the heavy French men-of-war, d'Estaing was afraid to cross the bar against the pilot's advice, and an earlier battle of the Nile was *not* fought. D'Estaing went first to the southward, then bore up for Newport, where the English destroyed a number of their vessels, 5 frigates and a

sloop, to prevent their falling into his hands. In the meantime the British reinforcements had begun to come in—scattered liners of Byron's command sent out from England and others. Howe with admirable industry and vigor hastened their repairs, put to sea and arrived off Point Judith but twenty-four hours behind d'Estaing. A strong northerly wind springing up that night, the latter left his anchorage and stood out to sea. The next day was passed in fruitless manœuvres on both sides. Then came a heavy gale which dismasted his flagship, damaged some of his other vessels and so discouraged him that he went to Boston, refitted and eventually sailed for Martinique. A more pitiable instance of great power in feeble hands is seldom recorded. Of results, he achieved none directly. The burning and sinking of the British ships in Narragansett Bay and the withdrawal of Sir Henry Clinton from Philadelphia were caused by his movements and not by his fighting, his strategy rather than his tactics.

D'Estaing paid us a brief visit the following year, 1779, on his way back to France. He tried to capture Savannah, then in the hands of the English. This was one of those bits of soldierizing so fascinating to the sailor. It resulted in failure and much loss of life. The French historian Chevalier,* however, remarks: "In spite of the check we suffered, the presence of the French squadron on the coast was not without value to the American cause. The English, ignorant of the point which we proposed to strike, were everywhere on the defensive. General Clinton, fearing that New York would be attacked by land and by sea, concentrated his forces in that city. By his order, Rhode Island was evacuated, and such was the precipitation of the retreat that the Americans found in the place provisions, munitions of war and pieces of artillery which it had been forgotten to spike." The quotation will serve to recall the suggestion already made as to the close relation that existed between the military strategy of the British and the integrity of their over-sea communications. It is proper to remind you that it was during this time that John Paul Jones was harrying her commerce within sight of England's shores.

On the 12th of July, 1780, the Chevalier de Ternay anchored in Narragansett Bay with seven line-of-battle ships and two frigates. Accompanying him were thirty transports carrying six

* Hist. de la Mar. Fran., p. 148.

thousand French troops under the Comte de Rochambeau. This squadron became but a passive menace to the English, for it played no part in active operations during many months, being either closely blockaded or contained by Arbuthnot at Gardiner's Bay. Admiral Rodney, though in command in the West Indies, left his own post to bring a powerful fleet to North America. Here are his reasons in his own words, which deserve quotation if only for the lesson they convey: "Having received certain intelligence by my several correspondents of the arrival of M. de Guichen at Cape François with the French fleet in very bad condition . . . with a certainty of a convoy . . . destined to sail from San Domingo to France under the protection of the French fleet, I had not a doubt but that part of that fleet was intended to reinforce the squadron under M. de Ternay, of whose arrival and taking possession of Rhode Island I had been assured by a captain of an American vessel. As it plainly appeared to me that His Majesty's territories, fleet and army in America were in imminent danger of being overpowered by the superior force of the public enemy, I deemed it a duty incumbent upon me to forego any emoluments that might have accrued to myself by the enterprise intended by General Vaughan and myself, . . . therefore, without a moment's hesitation, I flew with all despatch possible to prevent the enemy's making any impression upon the continent before my arrival there." For this readiness to go without orders to a place where he knew he was needed he received the encomiums of the Admirality. The First Lord, Sandwich, wrote him: "It is impossible for us to have a superior fleet in every part; and unless our commanders-in-chief will take the great line, as you do, and consider the King's whole dominions as under their care, our enemies must find us unprepared somewhere and carry their point against us." In Marshall's Life of Washington we read: "This reinforcement not only disconcerted all the plans of the allies and terminated the sanguine hopes which had been formed at the opening of the campaign, but placed it in the power of the British to project in security further expeditions to the South." Mundy, in his life of Rodney, states that "it appears from a private letter addressed by Washington to a friend at this period that he was in despair at Rodney's appearance on the American coast and at the non-arrival of de Guichen, the co-operation of whose fleet he had long been most anxiously expecting."

On sailing for Barbadoes late in the year, Rodney left with Arbuthnot enough vessels to make him superior to de Ternay.

The presence of the French squadron in Newport brought about a lasting change in England's naval position. From being free to act on the offensive, whenever and wherever it suited her purpose to move, she was at once thrown, in a measure, on the defensive. Whatever else she might undertake, this, at least, was imperative, that a sufficient number of powerful vessels should always lie off Narragansett Bay, or at some convenient anchorage near by, ready to engage on terms of superiority should de Ternay venture out. Gardiner's Bay was the point selected. Situated at the eastern end of Long Island, within easy reach of Newport, offering ample and secure shelter and possessing two channels of exit, one of which would be practicable in any wind, it held out exceptional advantages to the British, of which they were not slow to avail themselves. Accepting the logic of the military situation, Arbuthnot took post in Gardiner's Bay, where the bulk of the British ships of the line were chained until freed by the movements of the French.

Twice during the winter and spring of 1780 and 1781 the latter issued from Narragansett Bay: once but a small detachment towards the south; once in force, quickly followed by Arbuthnot.

The threat embodied in the existence of a French fleet at Newport served later to introduce confusion into the plans of the British Admiral Graves when de Grasse appeared off the coast. Much of the weakness of his measures may be justly attributed to his fear of being worsted in an encounter with de Grasse, who could, unlike Graves, count upon a substantial reinforcement after the action.

It had been the intention of the French government to despatch a second squadron to America and thus to make de Ternay stronger than Arbuthnot, but the close blockade of Brest interfered on the one hand as did Byron's arrival on the other. On the former's death the command devolved temporarily upon Captain des Touches, who succeeded in getting to sea at night in March, 1781, bound to the Chesapeake. His departure was quickly discovered and his destination guessed by the English, who hastened to bar his entrance into that bay, where Arnold was ravaging the country about Richmond and along the James, and whither Lafayette was marching with 1200 Continentals. The two

squadrons had each eight vessels, but the English counted in their line one ninety-gun ship while the French had one heavy frigate. They met off Cape Charles in a running fight, in which des Touches had rather the better of it, although he gave up his purpose and returned to Newport, while Arbuthnot anchored in the Chesapeake. Mahan says, "The way of the sea being thus open and held in force, two thousand more English troops, sailing from New York, reached Virginia on the 26th of March, and the subsequent arrival of Cornwallis in May raised the number to seven thousand" (Mahan, Sea Power, p. 387). By order of Clinton, Cornwallis occupied Yorktown, in which point the chief interest now centered. The combined French and American forces at Yorktown numbered about sixteen thousand. It is evident that Cornwallis' fate depended upon his communication by the sea. That such an elementary proposition should have been misapprehended by Graves, now in principal command of the British fleet on our coast, seems incredible, however true.

In justice to an officer upon whom rests the responsibility of disastrous failure, it is proper to state that at first Graves was misled by information from England into going with six sail of the line and two fifty-gun ships to cruise off George's Bank for the interception of an expected squadron of transports bringing reinforcements of French troops to Rochambeau. During his absence the pregnant news of de Grasse's probable sailing from the West Indies to America arrived in New York. The vessel sent thence to him fell among American privateers and was wrecked on Long Island, while a second despatch-boat carrying the more positive intelligence of de Grasse's actual start and destination was captured *en route*. Graves returned to New York, August 16. There was yet time for an active commander-in-chief to arrange measures by which to profit by the coming of Hood's squadron from the West Indies and to consider what ought to be done in reply to de Grasse's possible attack. Not only did he neglect to take any precautions under this head, but he seriously contemplated a joint expedition to Rhode Island.

Through Graves' return to New York a gap was left open into which de Grasse threw himself with a powerful force from the West Indies. A desultory action took place off the Chesapeake between de Grasse and Graves, of which the only result was to permit de Barras, des Touches' successor, to join de Grasse from

Newport and thus to secure for the latter an unquestioned preponderance. He entered the Chesapeake and completed the investment of Cornwallis, who surrendered on the 19th of October, 1781. On this day the war practically came to an end. Had Graves appreciated the paramount necessity of holding the Chesapeake in rear of Cornwallis, or had he met Hood at Cape Henry with his fourteen ships from Rodney's fleet instead of waiting for him at Sandy Hook, Cornwallis might have been saved.

It is impossible to overestimate the value of de Grasse's share in the great result. Says Mahan: "On the French side de Grasse must be credited with a degree of energy, foresight and determination surprising in view of his failures at other times. The decision to take every ship with him, which made him independent of any failure on the part of de Barras; the passage through the Bahama channel to conceal his movements; the address with which he obtained the money and troops required from the Spanish and French military authorities; the prevision which led him, as early as March 29, shortly after leaving Brest, to write to Rochambeau that American coast pilots should be sent to Cape François; the coolness with which he kept Graves amused until de Barras' squadron had slipped in, are all points worthy of admiration" (Mahan, Sea Power, p. 392). It was in no exaggeration of style that Washington wrote to de Grasse the day after the capitulation: "The surrender of York, from which so great glory and advantage are derived to the allies, and the honor of which belongs to your Excellency, etc." Washington states but the simple truth, the honor of the event does belong to de Grasse.

Mahan says, p. 397: "It must again be affirmed that its (the war's) successful ending, at least at so early a date, was due to the control of the sea—to sea power in the hands of the French and its improper distribution by the English authorities."

No naval event of importance took place during the remainder of hostilities. Raids were effected and single ships were taken, but the war ended at Yorktown. Fitful flames, as from the ruins of a freshly burned dwelling, alone indicated the existence of still smouldering embers. Parliament, in 1782, put a final stop to all offensive operations pending the negotiations of the terms of peace.

We have traced the course of events in a hasty and imperfect

manner, we have witnessed the gradual disappearance of our little navy, we have seen the happy advent at the critical moment of an allied fleet sufficient in numbers and power to compel success. In justice to those upon whom devolved the responsibility of conducting the nation's affairs, we must admit that the necessity of a certain measure of sea power did not continue to be unrecognized. As the war dragged on with its alternation of victory and defeat, the weak point of the British combinations became apparent, so that when the French alliance was effected, Washington, from whose decision there can be no appeal, laid this down as the first clause of his memorandum of concerted action submitted to the Comte de Rochambeau and the Chevalier de Ternay on July 15, 1780:

"1. In any operation, and under all circumstances, a decisive naval superiority is to be considered as a fundamental principle and the basis upon which every hope of success must ultimately depend."

That the campaign ending in the concentration upon Yorktown was a direct result of an assumed superiority of the French fleet is seen in his letter to Col. Laurens at Paris, dated 9 April, 1781: "On the first notice of the storm, which happened on the 22d of January, and of its effects, I intimated to the French general the possibility and importance of improving the opportunity in an attempt upon Arnold. When I received a more certain account of the total loss of the *Culloden* and the dismasting of the *Bedford*, two 74-gun ships belonging to the British fleet in Gardiner's Bay, I immediately put in motion, under the command of the Marquis de Lafayette, as large a part of my small force here as I could with prudence detach to proceed to the Head of Elk, and, with all expedition, made a proposal to the Count de Rochambeau and the Chevalier Destouches for a co-operation in Virginia with the whole of the fleet of our allies and a part of their land force. . . . It may be declared in a word, that we are at the end of our tether, and that now or never our deliverance must come. While, indeed, how easy it would be to retort the enemy's own game upon them, if it could be made to comport with the general plan of the war to keep a superior fleet always in these seas. . . ."

It is needless to multiply quotations. Washington's correspondence of this period abounds in reiterations of the same plea

for ships. Even after the capture of Yorktown, when other offensive movements were contemplated, he wrote to de Grasse suggesting a plan of further operations and said: "You will have observed that whatever efforts are made by the land armies, the navy must have the casting vote in the present contest." Had such a view prevailed six years before, how different would have been the course of events! Our forefathers learnt wisdom from an experience by which we should profit. It is easy for us, after the lapse of more than a century, and guided by the teaching of the new school in naval thought, of which Captain Mahan is the most brilliant exponent, to survey the war and point out the mistakes made on both sides.

It may be alleged that the poverty of the colonies was an all-sufficient bar to the acquisition of a suitable navy. To this it is difficult to make an answer other than to urge the imperative necessity, as proved by subsequent events, for proper ships under proper organization. At all costs and at all sacrifice they should have been obtained, for upon them ultimately depended our existence as a nation.

The fact is that Congress, at the outset, failed to appreciate the strategic form which the war was inevitably bound to assume. Herein lies a reason, cogent in itself, for the course which was actually adopted. When our public men finally came to a realization of our needs it was too late to repair the fault. Fortunate we were in securing from our friend and ally the means we had neglected to provide for ourselves.

Let us, in conclusion, recapitulate the deductions to be drawn from this study. They are six in number.

1st. A mistaken idea at the inception of hostilities of the ultimate importance of naval power.

2d. As a corollary to the above, a shipbuilding programme wrong in its details and wrong in its extent.

3d. A misuse of our great maritime resources, through which we failed to derive substantial benefit from a superiority in numbers afloat, which were nearly, if not quite, three to one in our favor.

4th. A neglect of tactical precautions in the case of a serious combined expedition.

5th. That the part taken by the sailor was not less important than that taken by the soldier.

6th. The termination of the war by the presence of an adequate naval force.

If these inferences be accepted as correct, it follows, as a broad generalization, that a sufficient navy is to-day of paramount importance to us in coast defense. Possessing it, we need have little fear. Without it, we shall be debarred from acting on the offensive-defensive and must remain content to retire from the sea, abandon our coastwise commerce and seek refuge behind the immobile works erected at the principal ports for their protection against the foreign fleets which a continuance of the old continental policy will assuredly invite to our shores. It is not meant to imply that our navy should rival in numbers that of a possible foe, but it is held and urged that, as our forefathers built sloops and frigates where line-of-battle ships alone would answer, we should profit by their unhappy experience and concentrate our efforts in naval construction on armored vessels until our fleet is strong enough to serve its true purpose, the avoidance of hostilities through its power to act with vigor and effect in the event of war. More than this we do not require, and more than this would be contrary to our traditions as a people who seek only peace with honor.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE DEVELOPMENT OF SMOKELESS POWDER.*

By Lieutenant JOHN B. BERNADOU, U. S. Navy.

The systematic development of improved ballistic properties from progressive explosives constitutes one of the most important ordnance problems of the present day. The idea is beginning to gain ground among us that hereafter we must look to the powder, as well as to the gun, in our efforts to increase the rapidity of flight and the penetrative power of projectiles; that we must consider the source of energy at our disposal conjointly with the apparatus whose function it is to convert that energy into useful work.

As long as the art of powder making remained at a standstill—as it practically did for several centuries—while the practices of alchemy, rather than the principles of chemistry, may be said to have controlled the manufacture of all explosives, the best that could be done was to follow the progress of mechanics in efforts to effect ordnance improvement; guns were built and powders were found to fire from them. To-day, however, not only is the composition of powder undergoing modification, but new explosive compounds, whose development is based upon chemical discovery, are coming into general use; the results of investigations into the chemical and physical properties of explosives, systematized and co-ordinated by the methods of mathematical analysis, have so increased our knowledge of ballistics, that designers of ordnance are forced to accept new conditions as factors of prime importance in the attainment of ballistic effect.

*Abstract of lecture delivered before the U. S. Naval War College, July 20, 1897.

For purposes of comparison, the old forms of powder, such as black gunpowder, may be regarded as imperfect mechanical mixtures of particles of the materials of which the powder is composed; the new explosives, as very intimate mixtures of the atoms of those elements from whose union into molecules the substance of the explosive is formed. When the old powder is employed as a fine dust it burns with great speed and violence; when agglomerated into grains * it burns in a slow progressive manner. If the grains of the old powders become disintegrated before they are completely consumed, through effects of heat and gas pressure developed in the bore of the gun, the grains crumble away; pressures become violent and regular progressive combustion ceases to obtain. Similar, but not identical conditions, exist for the new explosives. In the form of dust they burn with exceeding rapidity and great violence; when all the particles are decomposed simultaneously, they detonate; by building them up into dense grains they *may* be made, under favorable conditions, to burn progressively.

It was obvious from the start that many advantages were to be obtained by the substitution of the new explosives for the old as progressive powders. The former burned up completely, leaving no residue. Many of them made no smoke. Other conditions being equal, these two qualities alone would have been sufficient to justify their general adoption. But other conditions were not equal. Up to a few years ago the fact remained that no positive, certain way of making nitro-explosives burn progressively had been found. All known precautions could be observed in the preparation; they could be built up into dense grains with the greatest possible care; yet, every now and then a charge of the powder would detonate; that is, instead of burning progressively, in accordance with the finished form of its grains, it would burn as the dust from which the grains were built up. A gun would be shattered, perhaps a life or two lost, and then all confidence in the new material would disappear, the chosen line of development would be abandoned; no fundamental facts would be left unchallenged to anchor new hopes upon.

Until some way could be found, then, of firing a nitro-com-

* By "grain" is to be understood any regular form, flat strips, rods, cubes, etc.

pound from a gun with positive assurance that detonation would not occur, there could be no change from the old powders to the new. This assurance was obtained by the discovery that nitro-cellulose, colloided and formed into grains of regular size, would in all cases, if ignited in a closed space, burn away in a progressive manner, at a rate proportional to the form and dimensions of the grains and to the conditions of their confinement. Two proofs made the fact that colloids would not detonate certain; first, that the grains of colloid powders that were shot out of the gun without being completely consumed, preserved the original shapes, in reduced dimensions, of the grains of which the powder charge was primarily composed; second, that not tens, nor hundreds, but thousands of rounds of colloid powders, fired in guns or exploded in closed vessels, developed in every case pressures that could be shown to correspond rationally, in accordance with the theory of progressive combustion, to size and form of grains and to dimensions of gun chamber or explosion bomb. To make these facts certain, pressures were carried up beyond the 33,000 lb. limit allowed for cannon; and in explosion bombs to well beyond 100,000 lbs. per square inch.

Now, as the only certain way yet found of avoiding detonation and of assuring progressive combustion is through the colloiding of nitro-cellulose, and as nitro-cellulose alone can be colloided, it follows that we are definitely limited in our choice of material for progressive powders to a certain preparation of nitro-cellulose. It is true that a number of substances, such as nitro-glycerine and nitrates of metallic base, may be distributed in minute particles throughout the body of the colloid, and that immunity from simultaneous detonation may be secured for the particles so distributed; but they all remain uncombined in the colloid; the nitrates as the sand or minute shells in the body of a sponge, the nitro-glycerine as the water in the pores of the sponge. It is desired to emphasize by this comparison the fact that all the new powders, without exception, must be built up from some form of colloid nitro-cellulose, whether they contain other ingredients or not. Thus, in the case of those powders containing nitro-glycerine we may reduce the percentage of nitro-glycerine to zero; that is, we may eliminate it. If we were to remove the colloid nitro-cellulose from such a powder we

would have remaining nitro-glycerine, which would detonate in the gun upon the attempt to fire.

Nitro-cellulose, which is usually prepared by dipping cotton into nitric acid, possesses a property which the cotton, before dipping into acid, does not, *i. e.*, of dissolving in a number of substances. One of these is acetone, a volatile fluid, with a characteristic pungent and aromatic odor, somewhat suggesting common alcohol in appearance and properties. Another solvent for another kind of nitro-cellulose is a mixture of ether and alcohol. If the clear liquids which constitute the solutions in these substances be evaporated, there will be obtained, not the nitrated cotton, in its original fibrous form, but first, a syrupy liquid, then a jelly, and finally, as dryness is approached, a solid translucent mass, varying in color according to the variety of nitro-cellulose from which it is prepared, from a straw yellow to a chocolate brown, and generally suggesting, in its various forms, tortoise shell. To such a substance the appellation *colloid*, from its glue-like consistency, has been applied.

The general name for the material produced by steeping cellulose into nitric acid is nitro-cellulose. One of its common forms is gun cotton. Chemists are well aware that there are many different kinds of nitro-cellulose, but just how many there are no one has as yet even been able to predict, the exact composition of cellulose and of its nitro-derivatives remaining among the yet unsolved mysteries of nature. Three forms were originally assigned to it, the mono-, di- and tri-, just as there were the three forms of mono-, di- and tri-nitro-glycerine. A later investigator (Eder) succeeded in proving the existence of six. The authority of to-day upon the subject, whose views are now generally accepted (Vieille), has formulated eight. Now, just as there are many varieties of nitro-cellulose, so there are many varieties of colloids. The nitro-celluloses themselves all look alike; in their common pulped form they suggest fine white flour. They can be distinguished from one another with ease by the readiness with which some of them go into solution in certain solvents, while others remain undissolved in these solvents like so much sand. The fact that they possess such different properties is accounted for in practice by proven differences in chemical composition. It suffices here to state that there are a number of different varieties of the substance which form a number of

different colloids. The question of composition will be considered later in relation to the gases resulting from the combustion of nitro-compounds.

We are familiar with the kind of nitro-cellulose used for detonating purposes—gun cotton. We are also familiar with a form of colloid in common use to-day as a material. I refer here to celluloid, now very generally employed for the manufacture of a great number of useful articles. The nitro-cellulose from which celluloid is prepared may be made by steeping cotton in weak acids, and is rather a combustible than an explosive; it is a very different substance from the high explosive gun cotton, which is prepared from cotton by the use of strong acids. One solvent used to make celluloid is a mixture of ether and alcohol; the same solvent has no effect upon gun cotton, to dissolve which acetone must be used. We have, then, two different types of colloid to start with—celluloid (formed from weakly nitrated cellulose by the use of ether-alcohol), and the acetone colloid of gun cotton. It may be stated here that these two types of colloids represent all that is important in relation to colloid material for the manufacture of smokeless powder, as the matter has been understood up to a very recent date. The various colloids of the eight varieties of gun cotton above referred to range themselves under one or the other of these two types. We thus have two classes of colloid to experiment with, as gunpowder, and all the information we possess in relation to them is the fact that, however they may burn in the gun, yet they will not detonate.

Suppose that a number of rounds of powder are prepared from the two colloids, how will they act when fired from a gun of a given calibre? Let us assume that we have at our disposal the instruments commonly employed for the measurement of muzzle velocities and of bore pressures, the chronograph and pressure gauges; we will then have, as a basis of comparison, first, the ratios V/P of velocities to pressures*; second, our personal observations of other phenomena attending explosion.

Actual practice shows that the best results obtained for the two powders in a given gun, by varying weights of charge and dimensions of grain, would be about as follows:

*A convenient expression for comparing, in a given gun, the ballistic properties of different progressive powders,—V representing velocities in foot-seconds; and P, pressures in tons per square inch.

Gun cotton-acetone colloid	$V/P = 2100/15\text{-}19$
Celluloid nitro-cotton* colloided with ether-alcohol	$V/P = 2100/16$

Inspection of the results shows the existence of a pressure-range of from fifteen to nineteen tons for the acetone powder; this means that while no detonation would occur, yet that pressures would jump, between certain limits. Such a phenomenon is often observed in the tests of brown powders for heavy guns. A powder of this character would be unsuitable for general use by reason of pressure irregularity.

Upon firing the celluloid powder another and perhaps worse inconvenience would be met with. Considerable smoke would be developed and the interior of the bore would be found lined, after each round, with a heavy coating of soot, which, after one or two shots had been fired and the gun had become heated, would ignite after each succeeding round upon ingress of fresh air on opening of the breech, thereby producing flaming at breech and muzzle.

Obviously, as gunpowder, neither the one nor the other form of colloid is suitable. If they are to be employed they must be improved. Irregularity in pressures from the gun cotton-acetone colloid is due to brittleness; if we are to use this material we must devise some means of toughening it. The celluloid does not contain enough oxygen to consume its substance into gases; to use the latter we must put more oxygen into it.

The original phases of the colloid powder question thus present themselves. Neither the one nor the other form of colloid proving suitable for direct manufacture into powder, people began to try to improve them by combining them, or by adding foreign substances to them. It was well understood that no form of gun cotton, however highly nitrated, contained enough oxygen to effect its own complete combustion—the conversion of its carbon into the higher oxide of carbon, CO_2. The first idea of the experimenter was to add enough oxygen to the nitro-cellulose to thus complete its combustion, and this unfortunate attempt led to many years delay in the development of smokeless powder. It started investigators off upon a wrong track; complete combustion was one thing, and the work necessary to develop highest velocity with lowest bore pressure, another.

* Commonly called "Soluble nitro-cellulose."

With the purpose, then, of improving ballistic qualities of powders by causing them to consume completely and to develop regular pressures, experimenters in different countries began to try the effect of introducing into the colloid various foreign substances,—generally, oxidizing agents, such as nitrates of metallic base,—sometimes, when the mixtures became too violent in their action, a substance rich in carbon, called a deterrent, was added. Such work was a good deal like groping in the dark. There was no method in it. But there was one great incentive to keeping it up, viz., the fact thereby established that the addition of these nitrates to the colloids actually increased the velocity developed for a given bore pressure, whatever the inconveniences attendant upon the employment of these mixtures as powders may have been.*

To establish a comparison between the ballistic efficiencies of the two types of pure colloids above cited and of certain compound colloid powders into whose substance metallic nitrates or other oxygen carriers are incorporated, the following tabular record of performances of powders of these classes is submitted. Note is made therein of objectionable features developed for each of the explosives named.

TABLE I.

A.	B.	C.	D.	E.
Acetone, gun cotton, pure colloid.	Ether-alcohol, soluble nitrocellulose, pure colloid.	K, (primitive type, United States.) Blend of nitrocelluloses colloided in acetone, with metallic nitrates added.	BN, (France, commercial.) Blend of nitrocelluloses colloided in ether-alcohol, with metallic nitrates added.	Cordite, (Great Britain.) Nitro cellulose, colloided in acetone with nitroglycerine added.
$V/P=\frac{2100}{15 \text{ to } 19}$	$V/P=\frac{2100}{16}$	$V/P=\frac{2400}{15}$	$V/P=\frac{2400}{15}$	$V/P=\frac{2400}{15}$
Irregular pressures.	Deposits soot.	Some smoke and bore deposit.	Some smoke and bore deposit.	Erosion; doubtful keeping quality; some smoke.

*The increase in muzzle velocities for a given bore pressure to be attained by incorporating certain amounts of metallic nitrates, nitro-glycerine, etc., into the body of the colloid, constitutes a special phase of development of progressive powders, which will be discussed in a subsequent paper.

Referring to the table we find powders A and B with properties as already described. The K, BN, and cordite all make good ballistic showings, giving velocities greater by about 300 ft. sec. for a developed pressure than the former.

The last line of the table shows that each of the powders possesses certain unfavorable qualities which militate against its adoption for service use. The gun cotton-acetone colloid develops irregular pressures; the ether-alcohol colloid of soluble nitro-cellulose deposits soot; the K and BN produce some smoke and bore deposit. Cordite contains a volatile liquid, nitroglycerine, which develops great heat upon combustion. Now the development of highest velocity at lowest pressure is most important, even if obtained at the expense of the production of certain partially unfavorable conditions; but there was a further incentive to progress at this stage of development—the fact there had been found a form of pure colloid, unadulterated by admixture with other substances, which, while developing high velocities at moderate pressures, possessed the full round of good qualities necessary in a service powder.

The end sought for in the development of gunpowder is the attainment of the capability of delivering most accurately in a given interval of time the greatest number of most powerful blows; this result to be effected with minimum risk to gunners and with least possible injury to gun. Hereby is implied the fulfilment of a number of important independent conditions, no one of which may be overlooked in the effort to successfully accomplish the object sought. These conditions correspond to qualities possessed by a powder, and may be given, with their opposites, a general grouping under headings as follows:

TABLE II.

QUALITIES OF POWDERS.

	(1)	(2)	(3)	(4)	(5)
Positive.	Non-liability to detonation.	Development of minimum heat.	Formation of minimum residue.	Good keeping qualities.	Maximum propulsive effect.
Negative.	Detonation.	Erosion.	Smoke and bore deposit.	Decomposition.	Low value of V/P.

The first condition is of paramount importance and limits us to the employment of a colloid material. The second represents the fact that the greater the heat developed the greater the wearing away of the inner surface of the bore. The third requirement means obviation of bore deposit, which operates to reduce rapidity of fire by necessitating more or less frequent sponging, and to diminish accuracy of practice through the formation of smoke. The fourth requirement, stability, is all-important, when we remember that the ship must carry safely her store of powder for at least a cruise, and for the reason that when powders begin to decompose they lose their homogeneity and crumble—which means an end to regular pressure development.

Let us now take up requirement fifth—the attainment of maximum propulsive effect—and see what it leads to. What causes the expulsion of the projectile from the gun? The expansion of powder gases. What limits our employment of the expansive force of these gases? The attainment of the limiting bore pressure, this limit being commonly set at fifteen tons per square inch. What represents the greatest amount of work in the form of velocity? The greatest amount of gas expansion in the gun behind the projectile.

We desire, then, the greatest amount of gas expansion, but we are limited as to the rate of this expansion; that is, we must not let it develop in the bore a pressure greater than fifteen tons in the gun chamber or upon the interior walls of the piece. This is tantamount to saying that to produce maximum velocity we require the evolution, at a suitable limited rate of expansion, of the greatest possible volume of gas, the expansion of the gas constituting under these conditions the propelling impulse.

It may be stated here that we possess, *within limits*, the power of controlling the rate of combustion of colloid powders by varying certain conditions relating to combustion, the principal of which are (1) the size of the grains of which the charge is composed, (2) the volume of the powder chamber, (3) the length of the bore of the gun, (4) the weight of the projectile. Granting, then, that we possess within limits the capability of controlling the rate of evolution of the powder gases, we are led to the following conclusion: that the best smokeless powder is that stable colloid which, for a given weight of its substance, evolves in the bore of the gun at the most suitable rate of evolution and expan-

sion, the greatest volume of gas, the said evolution being accompanied with the development of the least heat.

We are led by this deduction to regard the action of the powder from a new standpoint. Besides considering what a powder is composed of, we must now consider what gases it is converted into upon decomposition and what volumes of these gases it generates. Most important of all, it leads us to conduct experiments for the purpose of ascertaining what colloid will, for a given weight of its substance, liberate the greatest volume of gases.

Here was one starting point for a series of experimental researches culminating in the discovery of an efficient smokeless powder. Another line of experimental approaches to the same end connected the efforts to toughen the substance of colloid films containing sufficient oxygen to effect their own complete combustion, with a view to the attainment of increased regularity in developed pressures; a third related to the determination of the causes of certain ballistic phenomena hitherto unexplained, *e. g.*, that acetone colloids developed, in some cases, greatly improved ballistic qualities, after the lapses of periods of from six to twelve months from time of manufacture. These several lines of experimental investigation proved in the end to converge towards the attainment of a common result—the development of a special form of nitro-colloid that possessed the toughness and therefore the regularity of burning of celluloid, and that contained enough oxygen to convert its substance, upon ignition, into wholly gaseous products—which the celluloid did not—and that liberated not only the greatest volume of powder gases at the most suitable rate, but the greatest volume of gases that can be evolved by any colloid at any rate of combustion, whether these colloids contained or did not contain nitro-glycerine, metallic nitrates or other substances.

The questions now present themselves: in what ways do we possess the control of kind and amount of gases evolved upon the combustion of nitro-cellulose and of its colloids; how does the constitution of these gases vary; what are they?

It has been already stated that the exact chemical formulae for cellulose and its nitro-derivatives have not yet been written. That for cellulose may be approximately expressed as $C_{6n}H_{10n}O_{5n}$ where n is an undetermined or indeterminate numerical quantity.

When cellulose is steeped in nitric acid or in a mixture of nitric and sulphuric acid, it is converted into the substance whose composition may be expressed as $C_{6n}\ H_{10n-an}\ O_{5n}\ (NO_2)_{an}$. These two expressions

$$C_{6n}\ H_{10n}\ O_{5n}$$
$$C_{6n}\ H_{10n-an}\ O_{5n}\ (NO)_{an}$$

may be considered in comparison with one another. Both contain the same quantity of carbon; the amounts present of the other elements are changed by nitration; *an* atoms of hydrogen are displaced by *an* equivalents of a combination of nitrogen and oxygen, (NO_2). This additional oxygen from the NO_2 acts to supply the energy that converts the cellulose into an explosive, and enters into its substance in combination with a certain amount of nitrogen. Why it carries the nitrogen with it we do not know, but it is a chemical fact that it does so—the fact upon which the designation of the new explosives as nitro-derivatives or nitro-explosives is based.

Upon the ignition of the nitro-cellulose or its colloid the nitrogen is set free; the hydrogen combines with its equivalent of oxygen and appears in the air as steam; the remaining oxygen unites with the carbon to form gaseous oxides of carbon. If there be not enough oxygen to consume all the carbon into gas, part of the latter is deposited as soot; this result was obtained in the attempt to employ celluloid as gunpowder. If there is enough oxygen to consume all the carbon into gases, we have, as products of combustion, a mixture of the gaseous oxides of carbon, of which there are two, CO_2 and CO. The property possessed by carbon of combining at high temperatures with intense energy with oxygen, to form gaseous oxides, is the fact upon which the practical development of explosives depends; there are many explosives that contain neither carbon nor oxygen, but with these we have as yet no practical relations in ordnance matters.

It has been stated already that the attempt to obtain what is called complete combustion for nitro-cellulose colloids by incorporating oxidizing agents into them had misled investigators, who confounded the attainment of complete combustion with the development of maximum velocity at lowest pressure. "Complete combustion" means the conversion of all the carbon into the higher oxide of carbon—carbonic acid, CO_2—a dense

gas about 1.9 times as heavy as the air, the formation of which is accompanied with the development of a high degree of heat. The complete combustion of carbon into carbonic acid gas with the corresponding evolution of a great amount of heat is the characteristic of the combustion of nitro-glycerine. The lower oxide of carbon, CO, is a gas much less dense than carbonic acid, possessing a density of about 1.4 times that of air. Suppose that we have a given weight of a compound of carbon and oxygen, with the elements taken in such proportions as to produce, on ignition, complete combustion into carbonic acid gas, CO_2, with the accompanying evolution of a large amount of heat; let us also suppose that we have an equal weight of compound of the same elements in such proportions as to develop, on ignition, the lower oxide of carbon, carbonic oxide, CO; then, the latter compound, developing the lower oxide, would liberate a volume of gas nearly $1.9/1.4 = 1.36$ times greater than the former. The greater heat produced by the formation of the carbonic acid gas would cause the volume of that gas evolved to be the more expanded, but, at the same time, and this is a fact of crucial importance in the present work, the greater heat would cause the gas to be generated at *a more rapid rate*, in fact, at an extremely rapid rate; and what we require is a low, regular rate of gas evolution to prevent our exceeding at any time the set limit of permissible bore pressure.

In our effort to generate from colloid nitro-cellulose the greatest volume of gas at the most gradual rate of expansion, we must seek, then, (1) to avoid the formation of CO_2 when CO may be formed in lieu thereof; (2) to avoid the formation of free carbon; (3) to generate the maximum amount of the lower oxide of carbon. If we give due consideration to the amounts of water and of nitrogen formed simultaneously with the oxides of carbon, we shall find that the form of nitro-cellulose developing the greatest amount of gas at the most suitable rate corresponds to the formula $C_{30}H_{38}(NO_2)_{12}O_{25}$, which breaks up on decomposition into $30\,CO + 19\,H_2O + 12\,N$.

This material is a new type of nitro-cellulose,* developed by

* This special form of nitro-cellulose, which corresponds to a content of nitrogen of 12.44 per cent. and which was first developed in Russia by the eminent chemist, Professor D. Mendeléef, has been independently developed at the Torpedo Station, through the study of effects of variation of times of immersion, temperatures of nitration and of washing, and strength of acids employed in the nitration of cellulose.

experiment to meet ballistic requirements, which contains just enough oxygen to convert its substance into a gaseous body. Its formation from cellulose depends upon strengths of nitric and sulphuric acid, temperatures of reaction and time of immersion of the cellulose in the acids from which the material is prepared. With ether-alcohol it forms a colloid that possesses, on the one hand, the toughness, and therefore the capability of development of regular pressures, of celluloid; and on the other the capability of consuming into wholly gaseous products that characterizes the gun-cotton acetone colloid; while as a powder it develops, with present types of guns, excellent values of V/P of about 2400/16. Briefly, it may be described as a celluloid containing enough oxygen to convert its substance (when it is consumed out of contact with the atmosphere) wholly into gaseous products.

(*To be continued.*)

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THE NAVAL POLICY OF AMERICA AS OUTLINED IN MESSAGES OF THE PRESIDENTS OF THE UNITED STATES, FROM THE BEGINNING TO THE PRESENT DAY.

By Hon. Theodore Roosevelt.

The following references * by Presidents of the United States to the urgent need of the United States possessing a proper Navy, corresponding to the nation's position as a great power, and ready at any time for efficient service in war, could be multiplied a thousand-fold from the speeches and writings of almost all the statesmen who have striven disinterestedly and intelligently for the true honor and greatness of America. By no means all of the references made by the Presidents themselves have been taken. Many of them, such as President Taylor's urgent appeals for the establishment of a retiring list, and pension list, and the improvement of the personnel of the Navy, or the recitals of the glory gained and conferred by the Navy in the war of 1812, and the civil war, are omitted because they do not bear on the problem of the present day, which is further to augment the Navy, both in materiel and personnel, in battleships, in torpedo-boats, in dry docks, in numbers of officers and men.

Fortunately the quality of the ships and guns, and of the officers and men, that we have, is excellent.

The utterances of the Presidents here quoted tell in outline the growth of the Navy. Washington first advocated its formation for reasons which apply now as forcibly as they applied when he wrote, over a century ago. What he said shows well how, on

* Where necessary they are slightly condensed.

this, as on all other questions, the greatest of Americans approached every problem of vital interest to America in a spirit of the broadest patriotism and statesmanship, combined with clear appreciation of the needs of the present and keen insight into the greater needs which the future would develop.

Under the elder Adams the navy which Washington advocated was actually begun, and even in its infancy it accomplished feats of note. The work of building it up was unwisely stopped, and the war of 1812 showed clearly the vital benefits conferred upon the nation by the little Navy which it possessed, and the terrible loss and damage caused by the fact that in size this Navy was but a small fraction of what it should have been. The utterances of Monroe, the younger Adams, and Andrew Jackson, show that the lesson was at least partially learned, and our Navy, though never brought up quite to the standard it should have been in point of size, was, nevertheless, maintained in a condition not wholly out of proportion to the needs and the honor of the nation.

Especial attention should be paid to the third quotation from Andrew Jackson. The victor of New Orleans had that "instinct for the jugular" which is possessed by every great fighter. All that he says applies to the present day, for, as he points out so clearly, the only effective defensive is the offensive; the only way to defend our own seacoast properly is to attack our enemy instead of waiting for him to attack us. It is for this reason that we can not afford to rely purely upon torpedo-boats or upon any kind of mere coast-defense vessels. Though it is of course absolutely necessary to have an abundance of torpedo-boats, we must also possess a powerful fleet of ships able to hold the seas, able to make long voyages, to stand rough weather, and to meet and overcome in the shock of actual fight any enemy's fleet; for it is the enemy's fleet which should be the true objective in naval war. Fortifications are indispensable, but they in no sense equal, or supply the place of, a fighting navy.

The effect of bringing the Navy up to something like a proper standard was shown in the inestimable services it rendered during the civil war. It is characteristic of Lincoln's far-seeing statesmanship and loving care for the welfare, ultimate as well as immediate, of the people for whom he was soon to lay down his life, that in the midst of the iron stress of the civil war, when the

problems of the present would have wholly absorbed any lesser man, he should yet have thought of the future in connection with our Navy, and should have advocated the building of those sea-going battleships which, though not needed in civil strife, would most assuredly be indispensable if the honor and renown of America were to be upheld against foreign powers.

After the close of the civil war there came a period of reaction and decline. In spite of President Grant's repeated warnings and protests, a spirit of unwise economy prevailed, and our Navy was suffered to sink below the level of that of even the third-rate powers. Then, in the middle of President Arthur's administration, the turn came; the people and their representatives awoke to what was demanded by national self-respect, the foundations of our present Navy were laid, and ever since then under every administration the work of building it up has gone steadily on.

In point of efficiency our ships need fear comparison with those of no foreign nation, and though they are not nearly as numerous as they should be, yet long strides in the right direction have been taken. To stop now would be to leave the work half done. But if we continue to build up our Navy for a few years to come, along the lines we have followed for the fifteen years immediately past, we shall, within a comparatively short period, place the United States where she should be, among the naval powers of the world. Such a Navy would be, as all of our great leaders from the days of Washington and the elder Adams to our own have pointed out, the surest guarantee of peace; and if by any unlucky chance we were to have war, it would not merely save us from material disasters, but what is of incalculably more moment, it would prevent that loss of national honor which would be felt as keenly in the farthest interior of the country as on the seaboard of the Atlantic or the Pacific.

THEODORE ROOSEVELT.

GEORGE WASHINGTON.

January 8, 1790.

To be prepared for war is one of the most effectual means of preserving peace.

ANNUAL ADDRESS.

December 7, 1796.

To secure respect to a neutral flag requires a naval force organized and ready to vindicate it from insult or aggression. This may even prevent the necessity of going to war by discouraging belligerent powers from committing such violations of the rights of the neutral party as may, first or last, leave no other option.

These considerations invite the United States to look to the means, and to set about the gradual creation of a navy.

However pacific the general policy of a nation may be, it ought never to be without an adequate stock of military knowledge for emergencies. This lack would impair the energy of its character and hazard its safety or expose it to greater evils when war could not be avoided; besides that, war might often not depend upon its own choice. In proportion as the observance of pacific maxims might exempt a nation from the necessity of practicing the rules of the military art ought to be its care in preserving and transmitting, by proper establishments, the knowledge of that art. The art of war is at once comprehensive and complicated. It demands much previous study, and the possession of it in its most improved and perfect state is always of great moment to the security of a nation.

JOHN ADAMS.

May 16, 1797.

Naval power is the natural defense of the United States.

December 8, 1798.

In demonstrating by our conduct that we do not fear war, for the necessary protection of our rights and honor, we shall give no room to infer that we abandon the desire of peace. Efficient preparation for war can alone insure peace.

The beneficial effects of the small naval armament provided under the acts of the last session are known and acknowledged. Perhaps no country ever experienced more sudden and remarkable advantages from any measure of policy than we have derived from the arming for our maritime protection and defense. We ought without loss of time to lay the foundation for an increase

of our Navy to a size sufficient to guard our coast and protect our trade. Such a naval force would afford the best means of general defense.

December 3, 1799.

A steady perseverance in a system of national defense commensurate with our resources and the situation of our country is an obvious dictate of wisdom; for nothing short of the power of repelling aggressions will secure to our country a rational prospect of escaping the calamities of war or national degradation.

November 27, 1800.

A navy, well organized, must constitute the natural and efficient defense of this country against all foreign hostility.

James Madison.

May 25, 1813.

The brilliant achievements of our infant Navy claim the highest praise and the full recompense provided by Congress.

December 5, 1815.

The signal services which have been rendered by our Navy and the capacities it has developed for successful co-operation in the national defense will give to that portion of the public force its full value in the eyes of Congress. To preserve the ships we now have in a sound state, to complete those already contemplated, to provide amply for prompt augmentations, is dictated by the soundest policy.

James Monroe.

January 30, 1824.

In the late war our whole coast was either invaded or menaced with invasion. There was scarcely an harbor or city on any of our great inlets which could be considered secure. In whatever direction the enemy chose to move with their squadrons and to land their troops, our fortifications, where any existed, presented but little obstacle to them. Their squadrons, in fact, annoyed our whole coast, not of the sea only, but every bay and great river throughout its whole extent. In entering these inlets and sailing up them with a small force the effect was disastrous, since

it never failed to draw out the whole population on each side and to keep it in the field while the squadron remained there. The expense and exposure of the inhabitants and the waste of property may readily be conceived. These occurrences demonstrate clearly that in the wars of other powers we can rely only on force for the protection of our neutral rights, and that in any war in which we may be engaged hereafter with a strong naval power, the expense, waste, and other calamities attending it, considering the vast extent of our maritime frontier, can not fail, unless it be defended by adequate fortifications and a suitable naval force, to correspond with those which were experienced in the late war. Two great objects are therefore to be regarded in the establishment of an adequate naval force: The first, to prevent war so far as it may be practicable; the second, to diminish its calamities when it may be inevitable. No government will be disposed to violate our rights if it knows we have the means and are prepared and resolved to defend them.

JOHN QUINCY ADAMS.

December 6, 1825.

A military marine is the only arm by which our power can be estimated or felt by foreign nations, and the only standing military force which can never be dangerous to our own liberty. A permanent naval peace establishment, adapted to our present condition and adaptable to that gigantic growth with which the nation is advancing in its career, is among the subjects which have already occupied the foresight of the last Congress. Our Navy, commenced upon a scale commensurate with the incipient energies, the scanty resources, and the comparative indigence of our infancy, was even then found adequate to cope with the powers of Barbary and with one of the principal maritime powers of Europe.

At a period of further advancement, but with little accession of strength, it has not only sustained with honor the most unequal of conflicts, but covered itself and our country with unfading glory. But it is only since the close of the late war that by the numbers and force of the ships of which it was composed it could deserve the name of a navy.

December 5, 1826.

We have twelve line-of-battle ships,* twenty frigates, and sloops of war in proportion, which, with a few months of preparation, may present a line of floating fortifications along the whole range of our coast. Combined with a system of fortifications upon the shores themselves, it has placed in our possession the most effective sinews of war and has left us at once an example and a lesson from which our own duties may be inferred. The gradual increase of the Navy was the principle of which the act of 29th April, 1816, was the development. It was the introduction of a system to act upon the character and history of our own country for an indefinite series of ages. It was a declaration of that Congress to their constituents and to posterity that it was the destiny and the duty of the United States to become in regular process of time and by no petty advances a great naval power.

Andrew Jackson.

March 4, 1829.

The increase of our Navy, whose flag has displayed in distant climes our skill in navigation and our fame in arms; the preservation of our forts, arsenals, and dockyards, and the introduction of progressive improvements in the discipline and science of both branches of our military service, are so plainly prescribed by prudence that I should be excused for omitting their mention sooner than for enlarging on their importance.

December 8, 1829.

Constituting, as the Navy does, the best standing security of this country against foreign aggression, it claims the especial

* Relatively to our size, and to the navies of other nations, this was a much larger naval force than we have now; and at the outbreak of the civil war in 1861 we were still relatively more powerful at sea than we are now. As regards men to draw on for manning our ships, we no longer have the great maritime commerce and fishing fleets we then had; but we now have, what we then did not, the men who work on the waters of the Great Lakes, and even of the rivers of the west, on whom we can also draw largely; and though our men must still be seamen to be efficient on board ship, and though they require a longer time than ever to learn their duties as men-of-warsmen, the gap between the seaman and the man ashore is no longer so wide as it was.

attention of Government, and should continue to be cherished as the offspring of our national experience.

March 4, 1837.

No nation, however desirous of peace, can hope to escape occasional collisions with other powers, and the soundest dictates of policy require that we should place ourselves in a position to assert our rights if a resort to force should ever become necessary. Our local situation, our long line of seacoast, indented by numerous bays, with deep rivers opening into the interior, as well as our extended and still increasing commerce, point to the Navy as our natural means of defense. It will in the end be found to be the cheapest and most effectual, and now is the time, in a season of peace, that we can year after year add to its strength without increasing the burdens of the people. It is your true policy, for your Navy will not only protect your rich and flourishing commerce in distant seas, but will enable you to reach and annoy the enemy, *and will give to defense its greatest efficiency by meeting danger at a distance from home.*[1] It is impossible by any line of fortification to guard every point from attack against a hostile force advancing from the ocean and selecting its object, but they are indispensable to protect cities from bombardment, dockyards and naval arsenals from destruction, to give shelter to merchant vessels in time of war and to single ships or weaker squadrons when pressed by superior force. Fortifications of this description can not be too soon completed and armed and placed in a condition of the most perfect preparation. The abundant means we now possess can not be applied in any manner more useful to the country, and when this is done and our naval force sufficiently strengthened we need not fear that any nation will wantonly insult us, or needlessly provoke hostilities. We shall more certainly preserve peace when it is well understood that we are prepared for war.

JOHN TYLER.

December 7, 1841.

Every effort will be made to add to the efficiency of the Navy, and I cannot too strongly urge upon you liberal appropriations

[1] The *italics* are my own.

to that branch of the public service. Our extended and otherwise exposed maritime frontier calls for protection, to the furnishing of which an efficient naval force is indispensable. We look to no foreign conquests, nor do we propose to enter into competition with any other nation for supremacy on the ocean; but it is due not only to the honor but to the security of the people of the United States that no nation should be permitted to invade our waters at pleasure. Parsimony alone would suggest the withholding of the necessary means for the protection of our domestic firesides from invasion and our national honor from disgrace. I would most earnestly recommend the increase and prompt equipment of that gallant Navy which has lighted up every sea with its victories and spread an imperishable glory over the country.

JAMES K. POLK.

December 2, 1845.

Our reliance for protection and defense on the land must be mainly by our citizen soldiers, who will be ever ready, as they ever have been ready in times past, to rush with alacrity at the call of their country to her defense. This description of force, however, can not defend our coast, harbors, and inland seas, nor protect our commerce on the ocean or the lakes. These must be protected by our Navy.

Considering an increased naval force, and especially steam vessels, corresponding with our growth and importance as a nation, and proportioned to the increased and increasing naval power of other nations, of vast importance as regards our safety, and the great and growing interests to be protected by it, I recommend the subject to the favorable consideration of Congress.

ABRAHAM LINCOLN.

December 8, 1863.

The duties devolving on the naval branch of the service during the year, and throughout the whole of this unhappy contest, have been discharged with fidelity and eminent success.

The events of the war give an increased interest and importance to the Navy, which will probably extend beyond the war itself.

The armored vessels in our Navy, completed and in service, or which are under contract and approaching completion, are

believed to exceed in number those of any other power. But while these may be relied upon for harbor defense and coast service, others of greater strength and capacity will be necessary for cruising purposes and to maintain our rightful position on the ocean.

No inconsiderable embarrassment, delay, and public injury have been experienced from the want of Governmental establishments (sufficient in number and adequate in character) for the construction and necessary repair of modern naval vessels. I think it my duty to invite your special attention to this subject. Satisfactory and important as have been the performances of the heroic men of the Navy, they are scarcely more wonderful than the success of our mechanics and artisans in the production of war vessels which have created a new form of naval power.

I commend to your consideration the policy of fostering and training seamen for the naval service.

U. S. GRANT.

December 5, 1870.

The appropriations made for the last and current years were evidently intended by Congress, and are sufficient only, to keep the Navy on its present footing by the repairing and refitting of our old ships. This policy must, of course, gradually but surely destroy the Navy. It can hardly be wise statesmanship in a government which represents a country with over five thousand miles of coast line on both oceans, exclusive of Alaska, and containing forty millions of progressive people, with relations of every nature with almost every foreign country, to rest with such inadequate means of enforcing any foreign policy either of protection or redress. Separated by the ocean from the nations of the eastern continent, our Navy is our only means of direct protection to our citizens abroad, or for the enforcement of any foreign policy.

December 2, 1872.

Unless early steps are taken to preserve our Navy, in a very few years the United States will be the weakest nation, upon the ocean, of all great powers. With an energetic, progressive, business people like ours, penetrating and forming business relations with every part of the known world, a Navy strong enough to

command the respect of our flag abroad is necessary for the full protection of all their rights.

December 2, 1873.

The distressing occurrences which have taken place in the waters of the Caribbean Sea, almost on our very seaboard, illustrate most forcibly the necessity always existing, that a nation situated like ours should maintain in a state of possible efficiency a Navy adequate to its responsibilities. Congress [should] provide adequately, not only for the present preparation, but for the future maintenance of our naval force.

Chester A. Arthur.

December 6, 1881.

I can not too strongly urge upon you my conviction that every consideration of national safety, economy, and honor imperatively demands a thorough rehabilitation of our Navy.

With a full appreciation of the fact that this must involve a large expenditure of the public moneys, I earnestly recommend such appropriations as will accomplish an end which seems to me so desirable.

Nothing can be more inconsistent with true public economy than withholding the means necessary to accomplish the objects intrusted by the Constitution to the National Legislature. One of these objects, which is of paramount importance, is declared by our fundamental law to be the provision for the "common defense." Surely nothing is more essential to the defense of the United States and of all our people than the efficiency of our Navy.

If we heed the teachings of history we shall not forget that in the life of every nation emergencies may arise when a resort to arms can alone save it from dishonor.

December 4, 1883.

The work of strengthening our Navy by the construction of modern vessels has been auspiciously begun.

That our naval strength should be made adequate for the defense of our harbors, the protection of our commercial interests, and the maintenance of our national honor is a proposition from which no patriotic citizen can withhold his assent.

December 1, 1884.

I can not too strongly urge the duty of restoring our Navy as rapidly as possible to the high state of efficiency which formerly characterized it. As the long peace that has lulled us into a state of fancied security may at any time be disturbed, it is plain that the policy of strengthening this arm of the service is dictated by considerations of wise economy, of just regard for our future tranquillity, and of true appreciation of the dignity and honor of the Republic.

GROVER CLEVELAND.

December 8, 1885.

All must admit the importance of an effective navy to a nation like ours. Yet we have not a single vessel of war that could keep the seas against a first-class vessel of any important power. Such a condition ought not longer to continue. The nation that can not resist aggression is constantly exposed to it. Its foreign policy is of necessity weak, and its negotiations are conducted with disadvantage because it is not in condition to enforce the terms dictated by its sense of right and justice.

BENJAMIN HARRISON.

December 9, 1891.

When it is recollected that the work of building a modern Navy was only initiated in the year 1883, that our naval constructors and shipbuilders were practically without experience in the construction of large iron and steel ships, that our engine shops were unfamiliar with great marine engines, and that the manufacture of steel forgings for guns and plates was almost wholly a foreign industry, the progress that has been made is not only highly satisfactory, but furnishes the assurance that the United States will before long attain, in the construction of such vessels, with their engines and armaments, the same pre-eminence which it attained when the best instrument of ocean commerce was the clipper ship, and the most impressive exhibit of naval power the old wooden three-decker man-of-war. The officers of the Navy and the proprietors and engineers of our great private shops have responded with wonderful intelligence and professional zeal to the confidence expressed by Congress in its liberal legislation.

There should be no hesitation in promptly completing a Navy of the best modern type, large enough to enable this country to display its flag in all seas for the protection of its citizens and its extending commerce. It is essential to the dignity of this nation and to that peaceful influence which it should exercise on this hemisphere that its Navy should be adequate, both upon the shores of the Atlantic and of the Pacific.

December 6, 1892.

I earnestly express the hope that the work which has made such noble progress may not now be stayed. The wholesome influence for peace and the increased sense of security which our citizens domiciled in other lands feel when these magnificent ships under the American flag appear is already most gratefully apparent. The United States is again a naval power.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

NOTES ON THE YACHT "DEFENDER" AND THE USE OF ALUMINUM IN MARINE CONSTRUCTION.

By RICHMOND PEARSON HOBSON, Asst. Naval Constructor, U. S. N.

Continued from No. 82.

The features that determine cost in a structure are: first, the cost of production, or first cost; second, the cost of maintenance, or care; third, the length of life.

D.—COMPARISON FOR FIRST COST.

The cost of production, or first cost, is made up of cost of material as supplied by the dealer or manufacturer, cost of labor expended in construction, deterioration of plant entailed, and interest on capital invested. The cost of labor is here taken to include draughting, superintendence, supply of power, etc.

1. Cost of Material.

a. Rolled Material.—The cost of ordinary mild steel used in hull construction may be taken at 2 cents per pound for both plates and shapes.

The cost of aluminum has not reached a steady level, continuing naturally to fall with the increase and improvement in methods of production. Roughly speaking, this increase in production has doubled each year for several years past, and though, for other causes, the fall in price has not been so rapid, it has

been pronounced and must be expected to continue for some time to come.

It is difficult, therefore, to assign to aluminum a definite value, and any value assigned must be considered as only momentary. For the purpose of comparison, however, the cost of rolled aluminum at the present time may be taken at 40 cents per pound for plates and 60 cents per pound for shapes, giving, compared with steel, the ratios per unit weight of 20 and 30 respectively.

(1) *Plates.*—As seen above, the ratio of weights for steel and aluminum in tension is .5 for equal ultimate strength, and .35 for equal elastic strengths. For plates, therefore, the ratios of cost in the two cases are 10 and 7 respectively.

The ratio of weights of plates for equal bending moments is .44 when working to the ultimate limit and .36 when working to the elastic limit. The ratios of costs, therefore, are 8.8 and 7.2 respectively.

The ratio of weight for equal stiffness is .648; the ratio of costs, therefore, is 9.6.

(2) *Shapes* of proportional dimensions.

The ratio of weights for equal bending moments when working to the ultimate limit is .55 for I beams and .58 for angles. The ratios of costs, therefore, are 16 and 17 respectively.

The similar ratios when working to the elastic limit are for weight .37 for I beams and .4 for angles, and for cost 11 for I beams and 12 for angles.

The ratio of weights for equal stiffness is .4 for I beams and .62 for angles. The ratios of costs therefore are 12 and 18 respectively.

b. Cast Material.—It will appear below, if not already evident, that aluminum is unfitted for heavy ship castings, such as stems, sternposts, shaft struts, etc., by nature of its small resistance to unusual violent shocks. The comparison, therefore, need extend only to small castings for fittings.

The cost of cast steel for hull fittings may be taken generally at 10 cents per pound. The cost of cast aluminum for the same fittings may be taken at 60 cents per pound. The ratio of costs, therefore, per unit weight is 6.

In the range of cast hull fittings, the castings and parts of castings serve the function of covering like plates, of stiffness like shapes, and attachments like simple bars. Some castings and

some parts of castings are designed with special regard to ultimate resistance, and others are designed with special regard to elastic resistance. The resistance in some cases is simple, in others compound. Taking a general mean for equality of resistance, the ratio of weight is .48. The ratio of costs therefore is 2.9.

Many cast hull fittings are made sometimes of cast steel, sometimes of cast brass; many are made exclusively of cast brass. It is therefore interesting to note that the comparison of aluminum with brass in these cases would give a ratio of weight of about .3 and of cost about .9. Recalling, too, that the two metals are more or less alike in relative softness and ease of working, it may be said roughly that the aluminum fittings giving the same strength as brass fittings have the same cost, with only one-third the weight.

It should be borne in mind, however, that this comparison, as also the comparisons with steel, assumes a degree of perfection in casting aluminum scarcely warranted at the present moment. It is given, however, in view of the rapid progress being constantly made in the new art of casting aluminum.

2. *Cost of Labor.*

a. For Rolled Material. (1) *Hull work proper.*—For steel the cost of labor in large hull work, plates and shapes may be taken at 4 cents per pound. For aluminum, on account of its newness and limited application, definite figures or results and estimates of the cost of labor in construction are lacking, and, despite of efforts, have not been attainable. The comparisons, therefore, must be limited to a general appreciation only.

The term labor, in estimates of hull construction, includes all operations of transportation and handling in yard and in shops, all operations of preparation of the material, laying off, punching, shearing, planing, bending, flanging, trueing, all operations of adjusting and securing in place, bolting, drilling, riveting.

In operations of transportation, handling and adjusting, the great lightness of aluminum work, less than half the weight of corresponding steel work, permits of marked economy in the number of men and length of time required.

In operations of tool work, planing, shearing, chipping, drilling,

etc., the greater softness of aluminum insures a similar marked economy. The same feature of softness gives a marked economy in riveting, all work being riveted cold, doing away with the portable forges and reducing the number of the riveting gangs.

On the other hand, the greater elastic elongation and the immensely smaller ultimate elongation of aluminum cause the operation of shaping, rolling, bending, flanging plates, bending and trueing shapes to be more difficult and more delicate, requiring longer time and greater skill. This drawback, evidently, is much more pronounced for shapes than for plates, the operation of trueing under the beam set involving, indeed, danger of destroying the integrity of the shapes.

The relative importance or amount of labor in these various operations depends evidently on the nature of the piece of work. Taking hull work throughout, and considering all the operations involved, the advantage sets emphatically to the side of aluminum in the case of plates, but is probably against aluminum in the case of shapes.

For the sake of continuing the numerical comparison, the advantage of aluminum over steel for plates is estimated at 25 per cent., while the advantage of steel over aluminum for shapes will be taken at the same figure. These figures, however, must be regarded as results of inductive judgment only.

Thus for aluminum the cost of labor in large hull work is taken for plates at three-fourths and for shapes at five-fourths the cost of steel for the same work.

Taking the weight ratios roughly at one-half, the cost of labor becomes for plate work 6 cents per pound and for shapes 10 cents per pound.

(2) *Hull fittings.*—For rolled steel the cost of labor in hull fittings may be taken broadly at 20 cents per pound.

The observations on the comparison for hull work hold in general for hull fittings. The operations of transportation and handling, however, become of less consequence, reducing the advantage of aluminum. On the other hand, the operations of shaping and trueing become likewise of less consequence, while the operations of small tool work, chipping, drilling, etc., become more pronounced in favor of aluminum. For the present purpose, therefore, the price ratio may be taken at three-quarters for shapes as well as plates; with the same weight ratio, the cost of labor for aluminum hull fittings becomes 30 cents per pound.

b. For Cast Material.—Confining the comparison, for the same reason as given above, to small castings for hull fittings, the cost of labor for steel castings may be taken broadly at 12 cents per pound. The cost of labor for aluminum castings for the same fittings may be taken at 16 cents per pound, giving a cost ratio of about two-thirds, using the same weight ratio of one-half.

3. *Other Costs.*

All other costs, including deterioration of plant, interest on capital invested, shop expense, supply of power, draughting, superintendence, etc., may be grouped together. For steel work the cost of the whole group may be taken at 25 per cent. of the cost of labor, in which the allowance for deterioration of plant is taken at about 10 per cent. per year and the interest on capital invested at about 10 per cent. per year.

For aluminum, it is evident that the lightness and softness will materially reduce the cost of deterioration of plant and shop expense, requiring less power, with less strain on machines, and less usure and dressing of tools. The group cost may be taken at four-fifths the cost for steel work.

These rates give the following results:

For Rolled Material.

	Cost of Labor.	Group Cost.
For steel hull work, plates and shapes.....	4c. per lb.	1c. per lb.
For aluminum hull work, plates.....	6c. " "	1.6c. " "
For aluminum hull work, shapes.....	10c. " "	2c. " "
For steel hull fittings, plates and shapes.....	20c. " "	5c. " "
For aluminum hull fittings, plates and shapes.	30c. " "	8c. " "

For Cast Material.

For steel hull fittings	12c. per lb.	3c. per lb.
For aluminum hull fittings.....	16c. " "	4.8c. " "

4. *Summation for First Cost.*

The results thus found for the elements making up first cost are assembled in the following table:

FIRST COST, CENTS PER LB.

	STEEL.				ALUMINUM.				Weight Ratio Aluminum to Steel.	Cost Ratio Aluminum to Steel.
	Material.	Labor.	Other costs.	Total.	Material.	Labor.	Other costs.	Total.		
FOR HULL WORK:										
Plates.....	2	4	1	7	40	6	1.6	47.6	.43	2.83
Shapes....	2	4	1	7	60	10	2	72	.48	4.98
FOR HULL FITTINGS:										
Plate work.	2	20	5	27	40	30	8	78	.43	1.24
Shapes....	2	20	5	27	60	30	8	98	.48	1.74
Cast fittings....	10	12	3	25	60	16	4.8	80.8	.46	1.48

The striking feature of this table is the reduced ratio of total costs, due to the fact that cost of material in which steel has so heavy an advantage is but one item, while cost of labor and other costs are items of much greater consequence, in which the advantage is slightly on the side of aluminum.

These results are specially pointed out in connection with the applications below, but attention may be called at once to the uniformly small weight ratio, a saving of over one-half in weight, and the comparatively small cost ratio for hull fittings and small castings, and to the marked difference of cost ratio between plates and shapes for hull work, the comparison for first cost thus pointing to the adaptability of aluminum in the following relative order: first, to plate work in hull fittings, with increase over cost of steel work of only 24 per cent.; next, to small castings in hull fittings, with increase of 48 per cent.; next, to shapes in hull fittings, with increase of 74 per cent.; next, to plates in hull work, with 2.8 times the cost of steel; next, to shapes in hull work with 5 times the cost of steel.

E.—COMPARISON FOR COST OF MAINTENANCE AND CARE AND LENGTH OF LIFE.

Obstructions have stood in the way of every advance in human industry. Scarcely an advantage has been won without antago-

nism and offsetting disadvantage. When, therefore, not many years since, the industrial world, wrestling with steel and iron, saw aluminum appear above the horizon as a commercial article, promising the great desideratum of strength without the penalty of weight and excessive hardness, it felt a thrill, and the more impetuous, foreseeing correctly the inevitable reduction of cost, thought that man had come into a new province without the strife of conquest, proclaiming in effect an abdication by terrestrial nature of her inexorable law of struggle.

The marine engineer and architect felt the elation above all others, for weight in construction material is the Goliath of their enemies. Only prudence and conservatism interposed to prevent precipitate application of the new metal. The conservative asked if aluminum was in truth a fully constituted David. The first reconnaissance showed an obstacle in the road, of huge proportions, not to be removed by the hand of a boy or the aim of a sling. Salt water and salt air were found to attack and disintegrate the metal.

Three notable cases of aluminum construction followed each other in rapid succession, the Vendenesse, built in France in 1892 and 1893, the Foudre, built in England in 1893 and 1894, and the Defender, built in the United States in 1894 and 1895. All three of these craft more than realized the expectations of performance, but all of them have demonstrated the weak point of aluminum. All have been exposed in varying conditions to the corroding action of salt air and salt water, and have contributed to the knowledge of this unfortunate phenomenon.

The Vendenesse, sloop-rigged sailing yacht, built at St. Denis, has her shell plating, decks and bulkheads of aluminum, 6 per cent. copper alloy, while her frames, keel and stringers are of steel, the weight of hull by this disposition being but 18 per cent. of the displacement.

Shortly after launching in December, 1893, she was dropped down to Havre, and lay in the salt water basin for about four months without attention. Her water line showing signs of corrosion, she was docked and her bottom was found bare with the paint off about 200 square metres of surface, part of the paint at least having been scraped off by obstacles while coming down the Seine. Examination showed corrosion wherever the metal was exposed, pitting being particularly pronounced around the edges of bare spots.

An investigation as to the causes of such pronounced results in so short a time showed, however, that part of the corrosion was undoubtedly due to galvanic action that set in from the proximity of a schooner with copper bottom, and, moreover, the basin received sewer discharges and had imperfect renewal of water.

The subsequent history of the yacht showed conclusively, however, that the metal would be attacked whenever exposed. It showed also practically continuous slow galvanic action, even between plates, both of which were of aluminum. The joints swelled and strained the rivets. One plate only would be corroded, showing lack of homogeneity and the existence of a voltaic circuit.

The deck plating was irregularly attacked; plates here and there had to be removed. The linoleum covering gave partial protection, but not immunity.

The excellent nautical qualities and the mechanical behavior of the metal made the yacht a decided success, but it was found that a specially prepared paint had to be used and that special care and almost constant attention were still necessary for even imperfect preservation.

The Foudre, second-class torpedo-boat, 60 feet long, 9 feet 3 inches beam, 4 foot draft, built by Yarrow for the French Government, and intended for the torpedo cruiser Foudre, is built practically throughout hull and hull fittings of aluminum, worked cold, realizing a saving of about 2½ tons, equal to about half the weight of hull, and about 25 per cent. the weight of total boat.

The stem and sternpost are of galvanized steel; the rivets, where exposed to bilge water, were of iron, elsewhere they were of aluminum; the inner tube of smoke stack and deck plating around smoke stack exposed to heat and a small part of the deck where special strength are required, are of steel. The propeller is of aluminum bronze.

The bottom and inside throughout were painted with red lead and the deck was covered with rubber canvas glued on. After successful trials in the fall of 1895, on which the speed realized was 1¾ knots in excess of contract speed, the boat was taken to Cherbourg and left at moorings all winter, apparently without being visited.

When examined the following spring, corrosion was found to be practically general. The outside of hull was pitted wherever exposed, and the inside was corroded practically throughout. Conning tower and hull fittings, exposed only to the salt air, were likewise uniformly corroded wherever uncovered, though the rubber canvas was effective in preserving the deck.

The result showed that red lead favored and produced corrosion. Moreover, when once begun, corrosion continues unless the metal is thoroughly scraped and cleaned before painting again. To clean the parts thoroughly would have required taking the boat to pieces, so general was the corrosion. The interesting little craft, so unfortunately treated, was practically given over to inevitable disintegration. The five sister boats, first ordered of aluminum, were changed to steel, and the torpedo cruiser was converted to an ordinary first-class cruiser, though it does not necessarily follow that this conversion was due alone to the failure of the aluminum boat.

Referring to the method of construction of Defender, given above, it will be recalled that the top side plating, deck beams, deck strapping, and upper fittings are of aluminum, 4 per cent. nickel alloy, the bottom plating is of bronze, and the stem, frames, floor plates and stiffening angles, bilge stringers, inverted angle bulbs under deck beams, the two deck beams enclosing mast, tie plates around mast, stepping socket, bed plate fittings and supports and chain plates are of steel, while the rivets are of bronze, making thus an intimate association of the three metals.

After completion afloat at Bristol in July, 1895, Defender was taken to New Rochelle. Examined there, the aluminum topsides were found to be in bad condition, with paint off in patches, particularly along water line, showing signs of corrosion along the seam of juncture of bronze and aluminum.

She was docked, washed, sand-papered and painted, and was similarly treated three times more before leaving for the races in September, on each of which occasions there were evidences of corrosion wherever the aluminum and bronze were in contact, and, to a less degree, wherever aluminum was water-washed.

Returning to New Rochelle after the races she was next examined in January, 1896, and was found to be corroded practically all over, corrosion being found underneath the paint, even

where it appeared solid. The inside, too, was slightly corroded all over, with severe corrosion in closets.

She was scraped throughout, washed with benzine and given four coats of paint on the outside and two coats on the inside. It may be recalled, in referring to painting, that the bronze surface of bottom is left bare.

The next examination, five months later, in June, showed corrosion at the water line, along the seam of juncture of aluminum and bronze and around rivet heads, a few rivet heads having fallen off, also corrosion around the chain plates, apparently due to leakage from deck. Corroded parts were scraped and touched up and deck leaks stopped.

The above examinations were made by the care-taker of the yacht, from whose log record the information is taken.

Two months later, in August, as previously referred to, an inspection was made by the writer, and the results, as above given, were fully confirmed.

It was found, in addition, that the cast fittings on deck, such as deck light frames, exposed on the whole to spray and salt air only, were in the last stages of consumption, and in many cases the spongy, honeycombed metal could be broken and crumbled with the hand. On the outside along the seam of juncture of aluminum and bronze, a close inspection showed a series of small mounds for practically the whole length. Upon puncture these mounds were found to be raised by the gray powder of corroded aluminum. On the inside this gray powder of corrosion covered the ledge formed by the top of the inside plating, the system being, as seen above, the raised and sunken system, and by jarring the sides more powder would sift down, showing a general process of corrosion.

Additional rivet heads were found fallen off and an examination of the fracture showed the force of rupture to be mechanical, there being nothing more than usual verdigris on the surface. The only way to account for this breaking off of rivet heads is the supposition of strains set up by the swelling due to the corrosion of the plates connected, combined with the slight elongation capable of being sustained by bronze. This swelling, as seen above, was found on the Vendenesse, and, moreover, appears inevitable when it is recalled that the process of corrosion forms a less compact substance, more bulky, than the metal.

Down from around a number of rivet heads and from the edges of the chain plates extended the yellow-brown streaks of iron corrosion. The steel frames and other steel work are being corroded by the bronze rivets and plates. The vessel presents undoubtedly a series, a network, of voltaic circuits, and it would be interesting to have a galvanometric survey.

Thus in Defender, too, we see a full realization of all the mechanical advantages sought in aluminum, and full satisfaction of behavior under stress of service; but we see too upon her the doom of a short life. In her system are working the fatal germs of the phthisis of corrosion.

Besides the three notable cases of the Vendenesse, Foudre and Defender, there have been others in which aluminum has been used to a greater or less extent, furnishing additional experience on preservation and length of life.

The Forban, first-class torpedo-boat, built for the French Government in 1893 and 1894, by Normand, at Havre, had her low pressure pistons and piston valves and her conning tower, galley, framing for turntables, torpedo tubes and other fittings of aluminum, realizing a saving in weight of about a ton. The results were unsatisfactory for all of these parts and fittings; the piston and valves did not meet the requirements for strength, though it should be recalled, as stated above, that even a comparatively low temperature must be expected to effect the strength of aluminum; the parts and fittings on deck within 12 months gave bad results of corrosion, flaking off in parts, notwithstanding care in painting. The result was that Normand abandoned the use of the metal.

On the torpedo-boats built at the New York Navy Yard and intended for the Maine, a number of cast fittings, principally on deck, such as stanchions, sockets, deck light frames, etc., were first made of aluminum. The metal exhibited brittleness and showed signs of corrosion, and in consequence was abandoned, though it should be stated that measures to prevent corrosion were not attempted.

Some of these fittings left exposed longer to sea air were entirely disintegrated, becoming spongy and flaky, and crumbling to gray powder as found in deck fittings of Defender described above.

Other craft have been built wholly or in part of aluminum,

but have not furnished data, yet attainable, on the corrosive behavior of the metal.

A twenty-three foot electric launch, of 8-knot speed, of about three thousand one hundred pounds displacement, built at Toulon for the service of the Navy Yard, is practically aluminum throughout—plating, stem and sternpost, frames, rivets, etc., realizing the remarkably small hull weight of 346 pounds, or one-ninth of the displacement, the plates being but .078" thick. The aluminum is 6 per cent. copper alloy. This little craft has been in use some time, and has probably evinced interesting features as to corrosion, complicated in all probability by the presence of the storage battery and motor for propelling, but information is not to hand as to results.

Another interesting craft, which in due time will probably give valuable information on the subject of the preservation of aluminum, has recently been built at Nyack on Hudson, a forty-foot launch, designed to develop 200 horse-power and exhibit a very high speed; designer, Chas. D. Mosher; owner, P. Magown, Esq.

This launch has her frames, bilge stringers, keelson, and deck beams of aluminum, the planking being mahogany and keel oak. Adequate measures have been taken in advance with a view to prevent or reduce corrosion. The aluminum is not in contact with copper or other corroding metals; it is nickel alloy, which alloy, as will be seen below, offers better resistance to corrosion than copper alloy, and is coated with 4 coats of special enamel.

The results of behavior under conditions of service will doubtless be valuable.

It may be mentioned here that a number of other craft have been built of aluminum for service in Africa and Madagascar, about twenty-five in all, many of which are built in sections for transportation on the backs of pack animals and couriers. Some of these craft have been in service for a number of years, the Etienne and Davoust being among the pioneers.

No returns have come as to behavior. They doubtless serve their purpose with efficiency, but, navigating fresh water, cannot furnish information of value on the question of corrosion, for, as seen below, aluminum has been found to resist effectually the action of fresh water. It is only salt water and salt air that assail it so disastrously.

The weight of experience, as thus seen above, sets against

aluminum. While the object sought in saving of weight was fully realized in each instance, and the mechanical behavior has been satisfactory in every respect, the metal has proved a uniform failure on account of galloping corrosion. When examined more closely, however, the results appear far from conclusive. In the case of the Vendenesse and Foudre the material was a copper alloy. Copper is far removed from aluminum in the electro-chemical scale, and should be expected to make an alloy specially liable to galvanic action; indeed the combination in the alloy itself practically contains the elements of a battery. As a matter of fact, the copper alloy, which offers but very slight, if any, advantage for resistance over other alloys, such as nickel, is the most corrosive of all, the zinc alloy perhaps excepted. Moreover, the paint put on the Foudre to protect it was itself an active agent of corrosion, and both vessels were exposed to conditions that would be severe for a steel hull. It is reported that the special paint used on the Vendenesse in three coats, the first coat having special properties against corrosion, the second against permeability of water, the third against fouling, has given results more or less satisfactory.

In the case of the Defender, while the nickel alloy is used solely perhaps for its physical properties, it is in direct and most intimate contact with bronze, no effort at insulation of any kind whatsoever being made, not even simple precautions that would have been insisted on in an ordinary case of steel and bronze construction. The yacht was built for one sole purpose—to win one series of races—and features not bearing upon that purpose were altogether ignored.

It is evident thus, that the case against aluminum is not complete, and the abandonment by the different governments of its further use in marine construction as a result of the excessive corrosion in the cases tried—this action, while conservative, and perhaps for the moment simply cautious—is by no means final.

The case is one that eminently calls for thorough scientific investigation and experiment, covering the range of alloys and the range of paints or preparations, those now existing and new ones that suggest themselves.

Partial and isolated experiments have already been made.

In connection with the decision to use aluminum for certain fittings for the torpedo-boats intended for the Maine, referred to above, and in connection with a proposition to introduce the general use of aluminum for hull fittings in naval vessels, tests

were made by the Naval Constructor at the Norfolk Navy Yard to determine the resistance to corrosion and fouling.

Two plates, 12" x 18" x $\frac{1}{16}$", furnished by the Pittsburgh Reduction Co., one of pure aluminum, the other of nickel alloy, were immersed with metal bare for three months in tideway water. When taken out in October, 1894, the nickel alloy plate was reported to be thickly covered with small barnacles and very considerably wasted away and corroded, and the pure aluminum plate was reported as "more thickly covered with larger barnacles and slightly pitted throughout its surface."

In January following another test was made.

Two plates were used, 14" x 16" x $\frac{1}{8}$", furnished by the Pittsburgh Reduction Co., one of pure aluminum, the other of 6 per cent. copper alloy. Both plates were immersed with metal bare for 136 days, being taken out for examination after 40 days, and remaining out for 8 days, being cleaned before reimmersion. When finally taken out the pure aluminum plate was reported as showing no signs of corrosion beyond a few small pits, and was only "very slightly fouled" with a "few small barnacles." The copper alloy plate, on the contrary, was reported as "covered with a quantity of small barnacles," "badly fouled and pitted over its entire surface."

These tests, in their limited extent, would indicate that the bare metal of both the copper and nickel alloy is subject to corrosion and fouling in sea water, and that the pure aluminum, commercially pure, was subject but very slightly to corrosion. On the fouling of pure aluminum the results are more or less contradictory, and would indicate a difference of material in the two cases, though indicating that the commercially pure metal is subject to fouling. The exact degree or rapidity of corrosion was not determined, and it would be difficult to compare same with the results for steel under similar conditions.

The above limited experiments confined to bare metal are, it appears, the only ones that have been made in this country under Government directions.

Private tests have been made, however, extending to the behavior of the metal when coated with preventatives of corrosion.

The most extensive of these tests were undertaken by Edward Smith & Co., of New York City, and conducted under the direction of Professor A. H. Sabin, the aluminum plates being furnished by the Pittsburgh Reduction Co.

The scope of the tests covered five different kinds or series of plates and six different coatings for each kind, making thirty plates in all.

The plates, carried horizontally, supported by the four corners in a rack, with about 2″ between plates, were immersed in the waters of the New York Navy Yard for six months.

The tests were described in a paper read by Professor Sabin before the American Society of Civil Engineers, contained in the Proceedings of the Society, vol. xxii, No. 7, September, 1896.

The composition of the plates, the nature of the coatings, and the results were as follows, as given in the paper above referred to.

COMPOSITION OF PLATES.

"Series I.—Ninety-nine and one-half per cent. pure aluminum.

Series II.—Ninety-eight per cent. aluminum and 2 per cent. copper.

Series III.—Ninety-eight per cent. aluminum (the quality known as commercially pure aluminum).

Series IV.—Ninety-three per cent. aluminum and 7 per cent. copper.

Series V.—Seventy-five per cent. aluminum, 20 per cent. zinc, 3 per cent. copper, 1 per cent. iron.

These plates were numbered from 101 to 130, and were coated as follows:

I.	II.	III.	IV.	V.	
101	107	113	119	125.....	'Sabin Process' pipe coating enamel, baked.
102	108	114	120	126.....	Durable metal coating, one side baked. Ultramarine blue, one side; flamingo red, one side; ground in varnish, not baked.
104	110	116	122	128.....	White zinc ground in varnish, one side baked.
105	111	117	123	129.....	Chromium oxide ground in varnish, one side baked.
106	112	118	124	130.....	Edward Smith & Co.'s spar varnish, no pigment, one side baked.

The varnish in which the ultramarine blue, flamingo red, white zinc and chromium oxide were ground was composed of 100 pounds Kauri resin to 20 gallons linseed oil, thinned with turpentine. The chromium oxide was the anhydrous oxide made by the ignition method, and was of commercial quality, not chemically pure. The baked coatings were baked about four hours at 215° to 240° F., except that the 'Sabin Process' pipe coating enamel was baked two hours at 400° F."

The condition of each plate after being taken out is given by Mr. Sabin as follows:

SERIES I.

"101.—Perfect.

102.—Baked side, perfect. Unbaked side, three blisters ¾ inch diameter. No general corrosion or roughening. The surface of the paint had lost its gloss. The coating was good on the edges of the plates.

103.—Ultramarine blue. Showed roughening of coating, numerous pin-head blisters, no corrosion to speak of.

Flamingo red. General condition good, except near edges of plate, which showed blisters over a surface about half an inch wide and one-fifth the marginal distance; very little corrosion.

104.—Baked side. About 2 square inches in one place half covered with small blisters. No corrosion.

Unbaked side. First rate condition.

105.—Baked side, one blister 1 x ½ inch; otherwise first rate. No corrosion. Unbaked side all right.

106.—Both sides perfect.

SERIES II.

107.—Perfect.

108.—Baked side, one blister ⅜ inch diameter. Unbaked side perfect.

109.—Blue and red about the same as 103, except that about twice as much surface was blistered. General condition good.

110.—Baked side badly blistered in spots along the edges, amounting to about 6 per cent. of the total surface of the plate. Some corrosion under these. Unbaked side all right, except that about 1 per cent. of the surface showed pin-head blisters along a strip about ½ inch wide on one edge of the plate.

111.—Baked side showed four central ¾-inch blisters, num-

erous marginal ones about 1½ per cent. of plate. Very little corrosion. Unbaked side in first rate condition.

112.—Baked side, two central blisters 2 square inches, and nearly all the margin ½ inch wide. Considerable corrosion. Otherwise perfect protection and higher lustre. Unbaked side, two central blisters ½ square inch and 1 square inch. Slight marginal corrosion. Coating evidently thin on edges.

Series III.

113.—At one corner evidently a break in the coating let in water and caused a blister of about 2 square inches. Coating rather overbaked and brittle; elsewhere perfect.

114.—Baked side perfect. Unbaked side tough and adherent, except one small spot near the middle of the plate, which looked as if coating had been broken, and where corrosion had begun.

115.—Blue and red about alike. No decided blisters, but coating itself showed some signs of decomposition, especially the blue, which had a rough surface.

116.—Both sides in good condition, but showed some signs of incipient blistering about the edges.

117.—All right on both sides.

118.—Both sides quite perfect.

Series IV.

119.—At several places about the corners of the plate single blisters, some of which were as large as 3 square inches, had formed. These appeared to be due to the fact that the coating was overbaked and had been cracked at the corners by the supporting framework, and galvanic action had ensued on the penetration of the sea water. This was facilitated by the 7 per cent. of copper in the alloy. The remainder of the plate was perfect.

120.—Baked side showed three blisters of about 1 square inch each and some corrosion under these; otherwise all right. Unbaked side perfect.

121.—Blue and red about alike; about 30 per cent. blistered and corroded.

122.—Pin-head blisters along the edges; general condition all right.

123.—Baked side all right. Unbaked side, seven or eight small blisters, but no corrosion. General condition good.

124.—Both sides badly blistered and corroded along the edge, about 10 per cent. of the surface. Where not blistered, all right.

SERIES V.

125.—Coating brittle and certainly overbaked. Badly blistered along the edges. In all cases of blisters under pipe coating enamel the blisters were continuous and started from the edge. The middle of the plate was all right.

126.—Baked side badly blistered along the edge—6 per cent. or 8 per cent. affected. Unbaked side slightly blistered, chiefly along one edge; condition otherwise good. No corrosion.

127.—Blue. Considerably blistered along the edges, in pinhead blisters mainly. Little corrosion.

Red. About the same, but some large marginal blisters. The red had a smooth surface, but the blue was rough.

128.—Baked side, nine or ten blisters of some size (1½ inches diameter), and considerable corrosion. Remainder of surface good. Unbaked side, about 1 per cent. of the surface, near the edges, with small blisters showing some corrosion. The rest of the surface all right.

129.—Baked side. A large number of groups (about 1 inch diameter) of small blisters. No corrosion. Unbaked side, about the same, but not so bad.

130.—About like 124.

The pigment mentioned as flamingo red is supposed to be a mixture containing some coloring matter derived from coal tar, and is reasonably permanent in the air. In these tests it became dark and mottled.

The baked surface of those plates which had one side baked were in all cases harder and more glossy than the other sides after the test was made. It should be observed, however, that while these coatings are all at present hard and firm, when they were first taken from the water they were much softer and could be more easily scratched or scraped off, with the exception of the pipe-coating enamel, which was exactly as it was when it was put into the water. Even the lustre was not affected, and the smooth plates coated with it are like a mirror.

On all the plates, except those coated with pipe-coating enamel which was applied by dipping, the coating is much thinner for about an inch along the edges of the plates than it is on the central portions. This fact has been called to the attention of the workmen who painted the plates, and is said to result from the method employed in applying the paint with a brush. In future experiments care will be taken to avoid this. Probably four-fifths of the corrosion occurred along this marginal strip."

The features of these tests, to be noted for the present purpose, are contained in the writer's remarks in the discussion of Professor Sabin's paper, part of which may be given as they were made, as follows:

"Alloys.—The prominent result of the experiments is that which shows that the corrosion increases as the amount of alloy increases, and that copper, as the alloy, particularly accentuates the corrosion. This result is striking in the comparison of the excellent results of Series III, where the alloy was simply 2 per cent. of the commercial impurities, with the unfavorable results of Series II, where the same amount of alloy, 2 per cent., was copper. The interest in this feature is special, for it requires an alloy to develop the best conditions for strength, while among the alloys suited to this purpose, copper, though prominent, is by no means exclusive."

"Coatings.—The experiments, it is noticed, are restricted to varnish and enamel preparations. The favorable results indicate a field for these preparations for the preservation of fittings, if not for hulls.

Interest would attach to comparative tests of these preparations and those used on ships' bottoms, also with special preparations thus far made, and that may be prepared especially for aluminum. A feature that suggests itself from these experiments is that the insulating qualities, as well as the porosity or permeability, may enter to affect results, and there would be interest in determining them in experiments to be made for comparative results. The generally unfavorable results with the baking process would indicate that the process increases the permeability, while the increase of adhesion counts for but little when galvanic action starts beneath. Interest also would attach to determining whether the paints themselves, or any of their components, enter into the phenomena."

"Conditions.—The close proximity of plates of different alloys which varied widely in their galvanic action, affected, in all probability, the results in the individual cases. As far as practicable, while still insuring the same conditions, plates of different alloys should be separated far enough not to affect each other. Even those of the same alloy, having the different coatings, should be arranged so as to affect each other as little as possible.

An analysis should be made as near as can be of the mean sample water of immersion, to determine the special agents, if any, that are present.

If practicable, sets of similar plates and coatings should be tested in different waters and analyses of the water made in each case.

Both coated and uncoated plates of the same and different alloys should be immersed in vessels with sea water of sample kinds, and analyses, qualitative and quantitative, made as follows:

Of the materials of the plates before and after immersion; of the water before and after immersion; of the protecting coatings before and after immersion. These tests should be made progressively, analyses being made at regular intervals.

In addition, the tests should extend to determining the insulating properties of the coatings, and their permeability or porosity, in different thicknesses.

The object of the experiments outlined is apparent. They contemplate, while determining comparative qualities of different alloys and different preparations, to determine the phenomena that take place, and to find each element that enters and the role and relative degree of importance of each."

It is to be regretted that these valuable tests, already extended so largely, covering so large a range of alloys and range of varnishes and enamels, were not still further extended to cover the compositions now used on ships' bottoms, Rahtjen's, McInnis, red lead, etc., for it seems that adequate tests for these compositions have not yet been made.

The care-taker of Defender, Mr. T. S. Mitchell, painter, of New Rochelle, made experiments, as he described orally, in search of a preparation, and found the usual paints all gave bad results. He finally determined on a special paint of his own preparation, which was used exclusively. This is a white paint, apparently a white zinc paint, that tarnishes and streaks badly

under weather, even under the drippings of condensation. Remark may be made of an experiment of Mr. Mitchell's which apparently reproduced the conditions found where the aluminum of Defender laps the bronze. A copper plate was placed on the back of an aluminum plate and put overboard. The result, of course, was a precipitate and destructive attack of the aluminum.

References may be made to a prior experiment with pure aluminum made in this country on the bottom of a wooden sailing vessel plying to the West Indies, where the test was comparative with copper.

The aluminum plate gave .005 in. corrosion where the copper plate gave .007 in. On the other hand the aluminum plate was foul with marine growth, while the copper plate was clean.

Abroad a number of experiments have been made.

In connection with the building of the torpedo-boat Foudre, Mr. A. F. Yarrow carried on a series of experiments, the results of which he describes as follows: "With reference to corrosion from sea water, we have tried a series of experiments, extending over twelve months, and we find, provided there is no galvanic action due to other metals being in contact with aluminum, the corrosion may be taken at under 4 per cent. for aluminum for plates about one-eighth inch thick, the surface being unpainted."*

This rate is not unfavorable in comparison with the usual rate for steel.

As a result of investigations of corrosion incident to the subsequent condition of the Foudre, M. Le Chatelier, Naval Constructor, French Navy, pronounced that aluminum is oxidizable in proportion to its impurities; that salt water affects the aluminum of commerce, but not pure aluminum; that pure aluminum resists oxidation as well as gold and platinum, and is not attacked by nitric and sulphuric acids, though dissolving in alkalies and hydrochloric acid.

M. Besson, Naval Constructor, French Navy, arrived at similar conclusions after investigations in connection with the building of the Davoust for African service, stating that corrodibility diminished as the quantity of copper impurities diminished, pure aluminum being practically incorrodible, the impurities most instru-

*See paper by Mr. Yarrow in the Transactions of the Institution of Naval Architects, vol. xxxvi, 1895.

mental in causing the corrosion being aluminum oxide, iron, carbon and silicon.

M. Guilloux, Naval Constructor, French Navy, designer and superintending constructor for the Vendenesse, who also inspected the Foudre after her corrosion, and who investigated the subject in conjunction with M. Minet, of the Ecole des Arts et Metiers of Paris, found that the usual assemblages of aluminum, taken at random, are liable to create batteries within themselves, and found that the more aluminum is electro-positive the better it resists salt water, and enjoined the following rules in the use of aluminum: 1. Choose aluminum as pure as possible. 2. Have the ingots mixed by fractional fusion to insure homogeneity. 3. Subject the material to galvanometric test and require it to be electro-positive to a piece already tried and found to give satisfactory resistance to corrosion. Take careful precautions during construction. Paint all surfaces and avoid absolutely all contact with copper.

In the paper in which these investigations were described, read before the Association Technique Maritime, which had been preceded by a paper on investigations in connection with the Vendenesse, M. Guilloux stated in conclusion that he regarded the metal as well adapted to marine construction, though delicate and as yet of irregular composition in production, while but slightly understood and insufficiently tried.

Experiments conducted at Neuhausen, Switzerland, in 1895, showed that pure aluminum was not attacked, while they showed that the copper alloys were badly attacked.

In connection with the application of aluminum to uses in the arts and industries ashore, various experiments have been made in the United States and abroad on its resistance to the usual agents that attack metals, noted among which experiments are those conducted by Professor Richards of Lehigh University. The uniform result has been the establishment of the fact that aluminum offers particularly great resistance, except in the case of alkalies and the chlorine group.

The experience in actual service and the experiments made, as outlined above, are inadequate to a definite and final conclusion as to the corrosion of aluminum in salt air and salt water.

The consensus, however, would lead to the following general conclusions:

1. When isolated, pure aluminum is not attacked.

2. When isolated, the usual alloys of aluminum and commercial aluminum are attacked in a measure more or less proportional to the amount or percent of the alloy or impurities. Among the alloys, copper and zinc seem the most corrodible.

3. When in contact or in communication with other metals below it in electro-chemical scale, galvanic action sets in and aluminum and its alloys are rapidly corroded. The action takes place when the contact is between different alloys of aluminum and even between different pieces of the same alloy, when not homogeneous; and there is indication that the corrosion of isolated alloys is probably due, in large measure, to the galvanic action between the particles of the two metals in the body of the alloy. Copper is again the metal whose contact causes most accentuated action, and the copper alloy is the alloy in which galvanic action is most marked.

4. The conditions of corrosion can be ameliorated by the application of coatings and coverings. The usual coatings for iron and steel, however, are not adapted to aluminum, particularly red lead. In case of special coatings, as yet prepared, special care and frequency of application are required. It would seem that the special characteristic to be sought is impermeability.

While drawing the above conclusions on corrosion, the imperfect behavior of steel and iron should be borne in mind. With full appreciation of this imperfection, however, the comparison of the two metals gives the following general results:

1. At the present stage, structural aluminum is materially more subject to corrosion than steel. The marked corrosion, however, must be attributed to galvanic action due to the high electro-positive character of aluminum, the pure metal itself, practically incorrodible, being far ahead of steel, and to this galvanic action must be attributed the corrosion of alloys and the usual commercial aluminum where even there is no external contact with other metals, the action taking place in the body of the metal from the intimate contact of the molecules of aluminum with the molecules of the alloying metals or impurities.

2. This feature of inferiority must therefore be regarded as subject to future amelioration from increase of knowledge and selection in the preparation of the alloys and from improvement

in conditions of insulation and protection. Substantial amelioration has already been found in the use of nickel for the alloy, without entailing loss of strength, while further amelioration seems promised in the use of tungsten for the alloy.

Special measures toward insulation seem not to have been taken or tested in any case.

3. The coatings used for painting steel are not effective in protecting aluminum, and the special coatings as yet prepared are but partially effective, and then only on condition of special care and frequent renewal.

4. This feature of inferiority must likewise be regarded as subject to future amelioration with further experiment and increase of knowledge. It could scarcely be expected to find a suitable coating without research, particularly when the usual coatings for steel are composed so largely of oxides of metals whose contact with aluminum sets up galvanic action.

5. The degree of importance of the inferiority of aluminum to steel in the question of corrosion varies with the conditions of exposure and is disqualifying when the exposure to salt water and spray is constant and where frequent visitation is difficult or impracticable.

The cost of maintenance and care and the length of life identify themselves, as seen above, with the question of corrosion. Without being able, evidently, to assign definite values, the cost of maintenance and care at the present moment must be taken as appreciably greater for aluminum than for steel. The cost of additional care is not of great consequence for parts easily accessible, provided the exposure is not great and the coatings applied or the other process of care are at all effective. For parts constantly exposed multiply the frequency of visitation, the additional cost is considerable, particularly where the parts are difficult of access. In such cases of exposure and difficulty of visitation, the inferior conditions of preservation reduce the length of life, which, under good conditions even, must be considered as shorter than the life of steel. This factor of cost takes on large proportions and, at the present moment, must be considered prohibitory for water-washed surfaces and parts in contact with bilge water, while still of large consequence for all outside parts, topsides, upper works, and upper deck fittings.

F.—Applications.

With the conclusions thus arrived at for cost of maintenance and length of life and the results of calculations for strength, weight and first cost, assembled in the table adjoined, a basis exists for judging between the two metals for adaptability to the various purposes of marine construction. For the present purpose and in keeping with the necessitated method of broad treatment, examination will be limited to salient features only.

1. *Adaptability for shell plating.*

(a). *For plating below water.*

(1). Bottom plating requires, besides elastic strength for structural stresses, special ultimate resistance to dynamic strains incident to grounding or even docking or moving alongside of wharves.

While adequate to the first requirement, aluminum, as seen, is altogether lacking in the second; an aluminum bottom would be penetrated and torn open where a steel bottom would only be deformed without perhaps springing a leak.

A torpedo explosion on the bilge or flank would shatter aluminum plating over a large area, bilging in all probabilities a larger number of compartments.

From considerations of strength, aluminum is thus unadapted for bottom plating of large vessels, unless reinforced by sheathing.

(2). Bottom plating is necessarily in constant exposure to salt water and beyond the reach of visiting except at long intervals when in dry dock. Considerations of corrosion, of care and shortness of life also unfit aluminum for bottom plating of vessels keeping the sea, unless they are sheathed.

Notwithstanding its advantages of lightness, aluminum is therefore doubly barred from use for bottom plating of unsheathed vessels keeping the sea.

(3). The application of sheathing to prevent fouling gives to steel bottoms an excess of resistance to penetration; its application to an aluminum bottom would supply the deficiency of resistance, and at the same time give protection from the contact of sea water.

TABLE OF RATIOS, ALUMINUM TO STEEL.

	STRENGTH.										
	Tension.		Comparison			Bending.				Costs.	
	Elastic.	Ultimate.	Elastic.	Ultimate.	Shearing.	Elastic.	Ultimate.	Stiffness, Flexion.	Weights.	Hull Work.	Hull fittings.
Simple resistance per square inch	.93	.66	.87	.57	.63						
Square Sections, equal tension, elastic	1	....	....	...	....	.96	.63	.38	.36	....	1.0
Square Sections, equal tension, ultimate	....	1	....	....	....	1.6	1.04	.75	.5	....	1.4
Square Sections, compression, elastic	....	...	1	....	....	1.07	.70	.44	.38	....	1.1
Square Sections, compression, ultimate	....	....	....	1	....	2.03	1.33	1.03	.59	...	1.7
Square Sections, shearing	....	....	....	....	1	....	....	....	.53	....	1.5
Square Sections, equal weights	....	....	....	....	....	4.50	2.90	3	1	....	2.8
Rectangular plates, equal tension, elastic	1	....	....	....	....	.99	.65	.41	.36	2.4	1.0
Rectangular plates, equal tension, ultimate	....	1	....	....	....	1.94	1.28	1.13	5	3.3	1.4
Rectangular plates, equal weights	....	....	....	....	....	7.8	5.1	9	1	6.6	2.8
I Beams, proportional dimensions, equal weights	....	....	....	....	....	4.45	2.91	3.08	1	10.4	3.6
I Beams, equal bending moments, elastic	....	....	....	....	....	1	....	.38	.37	3.9	1.4
I Beams, equal bending moments, ultimate	....	....	....	....	....	....	1	.82	.46	4.8	1.7
Angle bars, equal weights	....	....	....	....	....	3.59	2.35	2.3	1	10.4	3.6
Angle bars, equal bending moment elastic	....	....	....	...	....	1	....	.38	.4	4.2	1.5
Angle bars, equal bending moment ultimate	....	....	....	....	....	....	1	.58	.58	6	2.1

Dynamic resistance in tension, elastic, ratio of, per sq. in. .261, weight ratio .33.
" " " " ultimate, ratio very small, approximately inversely proportional to length.

Having a weight ratio of but .43, the aluminum bottom would realize a large saving, amounting in a 9000-ton vessel to about 200 tons, a large fraction of the increase of weight due to sheathing.

The cost ratio being 2.83, the increase of cost in the case considered would be about $90,000, or about 3 per cent. of the total cost of vessel.

A 3 per cent. increase of cost is a small price to pay for a 2 per cent. saving of weight.

The bottom would still be liable to corrosion from the inside, and until experiments have been made with cement and other bilge coverings, it would not be prudent to use aluminum even for sheathed bottoms in the parts where bilge water is liable to collect.

(4). For torpedo-boats and small boats considerations of stiffness determine the scantlings for shell plating. The fiber stress of girder calculation in such cases is less than half the stress admissible. To give the same stiffness, aluminum plates would be 1.34 as thick as steel, making a weight ratio of .48, but the same weight of aluminum plating would realize 9 times the stiffness. For stiffness, therefore, aluminum offers pronounced advantages. In cases of grounding, however, to which such boats are more or less liable in their operations in shoal water, the inferiority of aluminum in dynamic resistance would be in evidence as for the case of large vessels, debarring its use for keel plates and garboards.

When navigating in fresh water and when hauled up, such craft are removed from the corroding effects of salt water and sojourn in these conditions is more or less extended. The conditions of corrosion are therefore materially ameliorated, but would still require a suitable coating or paint of good resisting qualities.

The increase in cost would be similar to the increase in the case of large vessels, not at all prohibitory.

There are therefore material advantages to be gained in the use of aluminum for the bottoms of torpedo-boats and small boats generally, where saving of weight is precious and only the absence of a suitable paint stands in the way of adaptability.

(*b*). *For plating above water.*

(1). In conditions of usual service, plating above water does not require unusual dynamical resistance found necessary for the safety of bottom plating, and the pronounced greater elastic dynamical resistance of aluminum places it perhaps ahead of steel, notwith-

standing the great inferiority in ultimate dynamical resistance. In battle, however, the inferiority of aluminum would again appear in an emphasized form, in the increased wreckage and débris and multiplicity of splinters. The use of aluminum is therefore questionable in wake of gun protection and in the region of unprotected spaces occupied in battle. This is an important factor for unarmored war vessels and is serious for armored vessels, where, notwithstanding isolation of gun positions and the high degree of armor protection, the secondary battery is largely exposed, and fragments and splinters are still a menace.

The conditions of corrosion are severe just above the water line and would exclude aluminum from two or three strakes at least. For the topside above, subjected to intermittent spray and sea, the conditions of corrosion, though much less, are still serious and would require an efficient protecting coating.

The increase in cost is similar to the increase for plating below water and is not commensurate with the similar large gain or saving in weight.

(2). Fragments and splinters in battle do not enter the consideration for torpedo-boats and small boats and for mercantile vessels.

(3). There is therefore an important field for aluminum in plating above water, restricted only by the lack of a suitable coating.

2. *Adaptability for framing.*

Requirements of dynamic resistance exclude aluminum from use in framing behind armor and in general from all association with armor except the support of weight. They affect its use in gun positions and in other spaces occupied in battle where fragments and splinters are to be feared.

For framing elsewhere, however, the nature of its resistance would not incur disadvantage for aluminum, except to a certain extent for outer angles of frames and longitudinals.

Considerations of corrosion are against its use as outer or frame angles in the parts liable to collect bilge water, also as outer angles on longitudinals in the same regions. The conditions for the other parts are also more or less severe.

For the purpose of comparison, assuming the use for all longitudinals and transverse framing below protective deck and for

half the transverse framing above the protective deck, the saving in weight in a 9000-ton vessel of ample freeboard would be about as follows, with weight ratio .48 for shapes and .43 for plates:

Transverse framing below protective deck...					about 58	tons.
In angles and other shapes.....	about	30	tons.			
In platework, floor plates, brackets, gussets, &c.	"	28	"			
In transverse framing above protective deck, angles and other shapes.....				"	13	"
In longitudinal framing				"	45	"
In plates	"	32	"			
In angles	"	13	"			
Total.....					116	"

Total saving about 116 tons. With cost ratio of 2.9 for plates and 5 for shapes, the additional cost would be about $98,000, $69,000 additional for shapes and $29,000 additional for plates.

It is to be noted that the shapes realize only 56 tons of the 116 tons saved, while they entail $69,000 out of $98,000 increase of cost, illustrating the general fact of the smaller advantage to be gained in the use of aluminum for shapes than is to be gained in the use for plates.

In the present case, as pointed out, the outer angles are additionally subjected to severe conditions of corrosion. If therefore these remain of steel, the saving in weight would be about 16 tons less and the increase of cost would be reduced by about $20,000.

Considering the smaller advantage of weight, the larger increase of cost, the severer conditions for corrosion, and the lesser adaptability of resistance, it would appear advantageous to have the outer angles of steel even in the case of the adoption of aluminum for the plates and inner angles.

For these latter plates and angles decided advantage is to be gained in the use of aluminum when a suitable coating is found. Until this time, however, such use would not be prudent in view of the conditions of the double bottom and difficulty of access.

For framing below the protective deck forward and abaft the double bottom, and for framing above the protective deck, where not associated with armor, and where there is no special menace in battle from fragments and splinters, aluminum can be used with advantage in the present stage of progress, provided, as is

assumed throughout, that use is made of an alloy other than copper, and that due attention is paid to preservation.

For torpedo-boats and for small boats generally the conditions of corrosion of frames are not severe, and the frames are more or less accessible, excepting the lower parts of frames of torpedo-boats. The nature of its resistance being suitable, aluminum is therefore adaptable. General adoption for this purpose, however, should also be preceded by experiments to determine the coating best suited for preservation, while it should be borne in mind that the gain in weight of about one-half entails an increase of five times in cost.

3. *Adaptability for inner bottom.*

The nature of aluminum's resistance is suitable for inner bottom plating where the conditions of corrosion are not severe, due regard being taken to the conditions of the underside and the difficulty of access. With a coating of fair efficiency and with due attention, aluminum offers decided advantages for general adoption for inner bottoms. Taking the case of a 9000-ton vessel, the gain in weight with plates of equal stiffness would be about 30 tons, and the increase in cost would be about $16,000.

4. *Adaptability for bulkheads.*

The integrity of bulkheads is undermined as a rule by distortion destroying water-tightness, while rarely, if ever, is the metal called upon to exert its ultimate strength of resistance. The superior stiffness and greater elastic resistance of aluminum mark it therefore for special adaptability for bulkhead purposes, for both plating and stiffeners.

Standing vertically as it does, with ease of access and without exposure of any kind, the conditions for preventing corrosion are peculiarly favorable.

Aluminum therefore is eminently suitable for bulkhead purposes for all classes of vessels.

Taking a vessel of 9000 tons of unusual subdivision and high freeboard, and assuming equal stiffness, the saving of weight and increase of cost are about as follows:

	Weight Saved.	Increased Cost.
Transverse bulkheads below protective deck.....	45 tons.	$33,000
Transverse bulkheads above protective deck, W. T...	30 "	27,000
Transverse bulkheads above protective deck, light divisional	7 "	5,000
Longitudinal bulkheads below protective deck.....	96 "	77,000
Longitudinal bulkheads above protective deck.....	23 "	18,000
Longitudinal bulkheads above protective deck, light divisional	9 "	2,000
	210	$157,000

Total weight saved 210 tons, about 2⅓ per cent. displacement.
Total increase of cost $157,000, about 5 per cent. of total cost.

5. *Adaptability for decks.*

For reasons pointed out above, aluminum is debarred from association with the protective deck. The nature of its resistance, however, is suitable for other decks, both for beams and plating, exception being made for stringers and tieplates, reservation being made also for considerations of fragments and splinters in battle as pointed out above.

For beams, however, with the present conditions of manufacture, the sizes required for large vessels, for which there has yet been no demand, could probably be produced only with increased difficulty, though for the present purpose it will be assumed that they could be produced at the price quoted above for shapes.

Conditions of corrosion would exclude the use for the upper deck unless the plating were covered by wood flat. As a matter of fact such a wood flat is found, as a rule, on the upper deck of war vessels where the deck is of steel. All other decks would require efficient linoleum or other covering on top and an efficient coating on underside. For structural purposes the deck stringers would remain of steel.

For a vessel of 9000 tons, supposing the decks except the protective deck to be of aluminum, both plating and beams, the saving of weight and increase of cost, assuming equal stiffness, would be about as follows:

	Weight Saved.	Increased Cost.
Main deck	about 85 tons.	about $60,000
Gun deck	" 60 "	" 42,000
Berth deck	" 67 "	" 47,000
Platform deck	" 21 "	" 15,000
Flats and floors	" 2 "	" 1,000
	235	$165,000

Total weight saved about 235 tons, about 2⅔ per cent. of total weight.
Total increase of cost about $165,000, about 5½ per cent. of total cost.

6. Adaptability for other hull work.

(1). For casings and trunks the same advantageous conditions are offered for aluminum as pointed out in the case of bulkheads. For a 9000-ton vessel the saving in weight would be about 45 tons, about 51 per cent. of the weight in steel, with an increase of cost of about $30,000, about 2⅓ times the cost in steel.

(2). For small trunks and ducts, coaling trunks, ventilator trunks, forced draft ducts, ammunition hoist trunks, chain lockers, blower casings, the same conditions hold; the saving in weight would be about 32 tons, and the increase in cost about $21,000, bearing about the same ratios to total weight and cost in steel as found for casings and trunks.

(3). Similarly for hammock berthing where the saving in weight would be about 14 tons, and the increase in cost about $9000, bearing about the same ratios to total weight and cost in steel.

(4). For metal ceilings inside the same conditions hold, giving a saving of about 6 tons with an increase of cost of about $4000, bearing about the same ratios to total weight and cost in steel.

It should be remarked that the greater conductivity of aluminum would increase the condensation, requiring special provision against same in living spaces.

7. Adaptability for hull fittings.

(1). For the ventilating system, the conditions for corrosion are not severe and there are no special requirements for resistance. Aluminum is therefore suited to the air ducts and fittings, and the pipes and cowls, into which forms it can be readily made and is easily worked. On the vessel taken for the comparison the saving in weight would be about 20 tons, with an increase of cost of only about $8000, the cost ratio being taken at 1.24. About 3½ tons are saved in the copper and brass cowls, rims and hoods, without increase of cost.

For the cowls, too, the lighter weight affords greater ease of manipulation for trimming to wind.

(2). For metal doors, water-tight and non-water-tight, the advantages of aluminum are in special evidence. For water-tight doors, the stresses are similar to those of bulkheads, the main consideration being stiffness and resistance to deformation. The distinctive superiority, however, lies in the greater ease of

opening and closing afforded by the lighter weight. On the vessel in question the saving in weight would be about 18 tons and the increase of cost but about $6000. There would be advantage for the substitutions for some wooden doors, as to staterooms, where lightness is also specially desired.

(3). For hatches (other than armored), man-hole covers and frames, the same considerations hold. The saving in weight would be about 11 tons, with an increase in cost of about $4000.

(4). For torpedo ports and coaling ports, the special advantage of ease of handling is again in evidence, though the conditions of corrosion would require an effective coating on the outside. The saving in weight would be about 5 tons and the increase of cost about $2000.

(5). For dead light, air port, and deck light frames and casings, cast aluminum would be well suited provided due attention is given to consideration of corrosion, proper care in selection of material of castings, and application of effective coating. The saving of weight over the brass castings would be about 15 tons without any considerable increase of cost.

(6). For metal ladders and gratings, ease of handling due to lightness gives a distinct advantage, and conditions of corrosion are not severe. The saving of weight would be about 3 tons and increase of cost about $1000. There would also be advantage in many cases in the substitution of aluminum for wood gratings.

(7). For masts and spars the advantage of lightness is in special evidence as reducing high weights, and the conditions of corrosion are not severe. Aluminum is therefore well adapted for usual service where sails are not carried and unusual forces are not to be resisted. It is to be noted, however, that in battle an aluminum lower mast would be more likely to be shattered and drop its charge of military tops, etc. For the lower booms, or boat booms, lightness offers additional advantage for rigging in and out.

The substitution in the case of a vessel carrying two military masts of usual development would be about 14 tons, the increase of cost about $7000.

(8). Among additional miscellaneous fittings for the application of aluminum may be mentioned fresh water tanks, galley outfit, furniture, ammunition boxes, binnacles, lanterns, etc.

Reference has been previously made to the fact of aluminum's

being largely debarred from boiler and engine application on account of the overthrow of its physical properties by heat, even at comparatively low temperature. It should be pointed out, on the other hand, that this obstacle is not incurred in a number of applications in the engine and fire rooms, such for instance as the parquets or floors, envelopes of boilers and condensers, condenser tubes, etc. In connection with the use for condenser tubes it would be necessary to avoid the use of alkalies like soda in cleaning. In the above and in many other applications the lightness of aluminum would be in large advantage, particularly for reciprocating parts. In other applications, to parts of machinery where unusual forces are not to be feared, where the oft repeated forces are well known, the high elastic dynamic resistance would in addition be of decided advantage. For the present purpose, however, this field of application is not investigated.

(9). The above applications, assembled, are as follows:

First, where, at the present stage and under the present condition of manufacture, aluminum could be used to advantage, provided a suitable alloy other than copper is used, and provided due care and attention are given to preservation, as follows:

For Hull work.

	Case of 9000-ton Vessel. Saving in Weight.	Increase in Cost.
Bulkheads	210 tons.	$157,000
Casings and trunks	45 "	30,000
Small trunks and ducts	32 "	21,000
Hammock berthing	14 "	9,000
Metal ceilings	6 "	4,000
Total in hull work	307	$221,000

For Hull fittings.

Ventilation system, ducts, pipes, cowls, and fittings	20 tons.	$8,000
Metal doors	18 "	6,000
Hatches	11 "	4,000
Torpedo ports and coaling ports	5 "	2,000
Metal ladders and gratings	3 "	1,000
Masts and spars	14 "	7,000
Total for hull fittings	71 "	$28,000
Total for hull work	307 "	221,000
Total	378	$249,000

Thus, at the present state of manufacture and with present means of preservation, there could be realized with safety on a vessel of 9000 tons a saving of about 380 tons with an additional expenditure of about $250,000, or an economy of about 4¼ per cent. of the total weight of vessel with about 8⅓ per cent. entailed increase of cost. The relative advantage is most marked in the case of hull fittings, where the saving of weight is about 14 per cent. of total weight of hull fittings, and the entailed increase of cost is only about 8½ per cent. of total cost of hull fittings.

Second, where aluminum can be used with advantage as soon as experiment finds an efficient coating against corrosion, as follows:

For Hull work.

	Case of 9000-ton Vessel.	
Shell plating.	Saving in Weight.	Increase in Cost.
Bottom plating of small vessels		
Bottom plating of large vessels when sheathed...	200 tons.	$90,000
Topside plating of small vessels		
Topside plating of large vessels when not associated with armor or armored spaces occupied in battle		
Framing.		
Bottom and topside framing for small vessels....		
Bottom framing except outer angles of transverse frames and longitudinals in double bottom, and topside framing for large vessels.....	100 tons.	$78,000
Inner bottom plating	30 "	16,000
Decks, plating and beams	235 "	165,000
Total for hull work for sheathed vessel....	565	$349,000
Total for hull work for unsheathed vessel..	365	259,000

For Hull fittings.

Dead lights, air ports and deck light frames and casings	15 tons.	000
Total for hull work	365 "	259,000
Total	380	$259,000

Thus, as soon as an efficient preservative coating is found, a further field will be opened up where with a 9000-ton vessel an additional saving of 380 tons could be realized by an increase of cost of about $510,000, or a saving of about 8½ per cent. of total weight and an increase of about 8⅔ per cent. of total cost.

When thus occupying its whole legitimate field in hull construction, the use of aluminum would realize, in a 9000-ton vessel, a saving of weight of about 760 tons with an entailed increase of cost of about $510,000, or a saving of about 8½ per cent. of total weight with an increase of about 17 per cent. of total cost.

It should be recalled that the above results apply to a vessel of war, and for the present purpose it will suffice to point out that for a merchant vessel, where conditions of battle are not taken account of, the application would be larger.

* * * * * * * * *

G.—Summation—Conclusions.

The above comparisons lead to the following results:

Comparison for Strength and Weight.

1. In simple tension, aluminum, which is about ⅓ as heavy as steel, has about ⅔ of the ultimate and about $\frac{14}{18}$ of the elastic resistance.

In simple compression and shearing the ratios are slightly smaller.

2. In bending, aluminum bars of square section having the same weight as steel give about 2.9 times the ultimate strength and about 4.5 times the elastic moment of resistance, and are about 3 times as stiff.

Aluminum plates of equal weight give about 5.1 times the ultimate and about 7.8 times the elastic moment of resistance, and are about 9 times as stiff.

Aluminum shapes of proportioned dimensions of equal weight give for I beams about 2.9 times the ultimate and about 4.5 times the elastic moment and about 3.1 times the stiffness, and for angles about 2.4 times the ultimate and about 3.6 times the elastic moment, and about 2.3 times the stiffness.

3. In elastic elongation, aluminum gives about 2.8 times the elongation of steel with a modulus of elasticity of about ⅓ of steel. For elongation beyond the elastic limit, aluminum is incomparably below steel, the ratio being smaller as the length increases.

The dynamic resistance of aluminum in tension within the elastic limit is, therefore, about 2.6 times the resistance of steel

per unit of cross section, and is about 7.8 times the resistance for equal weight.

Beyond the elastic limit the dynamic resistance of aluminum cannot be compared with the resistance of steel.

Comparison for Cost.

1. To realize the same resistance, plate work in aluminum costs, in general, about 2.8 times as much as steel in hull work and about 1.2 times as much in hull fittings; angle work and work in other shapes cost, in general, about 5 times as much in hull work and about 1.7 times as much in hull fittings.

Cast fittings in aluminum cost about 1.5 times as much as in steel and about the same as in brass.

In all of these cases the weight for aluminum construction is less than half the weight for steel and about ⅓ the weight for brass.

2. The cost of maintenance and care is at present substantially greater for aluminum construction than for steel construction, and increases in proportion to the exposure to corrosion, which becomes exaggerated where conditions favor galvanic action.

3. The length of life of aluminum construction under favorable conditions must be regarded at present as substantially shorter than the length of life of steel construction, on account of pronounced tendency to corrosion. This tendency has been found to be due in most part to galvanic action, largely caused by the alloy or impurities in the metal, an alloy being necessary to realize good results of strength. Of the alloys tried, the copper alloy has given the worst results for corrosion.

As yet a suitable protecting coating has not been found and the field is calling for further scientific experiment.

The cases of the employ of aluminum have been unfortunate in results of corrosion, but they have been incomplete and the conditions, upon examination, have been found to have been extremely severe.

With a properly chosen alloy, like the nickel alloy, and with proper care, aluminum can be safely used where there is not direct exposure to salt water and spray, and the further extent of the advantageous use to fields where the exposure is not specially severe is only held back by the lack of an efficient protective coating.

Applications.

The results of the comparisons for strength and weight and for cost lead to the conclusion that at present aluminum is adapted for use in hull work for bulkheads, casings and trunks, small trunks and ducts, hammock berthing and metal ceiling, and for use in hull fittings for parts of ventilation system, for metal doors, hatches, torpedo ports and coaling ports, metal ladders and gratings, masts and spars, this adoption in the case of a 9000-ton vessel realizing a saving in weight of about 380 tons at an increase of cost of about $250,000.

The same results lead to the conclusion that as soon as an efficient coating is found aluminum will be further adapted for the bottom plating of sheathed vessels, for the bottom and topside plating of small vessels, part of the topside plating of large vessels, for bottom and topside framing of small vessels, for topside framing of large vessels, for the bottom framing of large vessels except outer angles in double bottom, for inner bottom plating, and deck plating, and for dead light, air port and deck light frames and casings, realizing by this adoption in a 9000-ton vessel a saving in weight of about 380 tons at an increase of cost of about $260,000.

It is to be remarked that in the above applications it is assumed that galvanic action does not set in from the contact of aluminum and steel, an assumption apparently justified by experience thus far; but in course of time it is largely probable that appreciable action would set in, if some insulating provision were not made in the joints between the two metals. It is not believed, however, that such insulation provision would be impracticable.

It may be recalled also, as stated in the outset, that performances and homogeneity of aluminum as taken are somewhat ahead of the present stage of manufacture, and that the applications have been extended to dimensions and scantlings not yet commercially turned out.

Moreover, it should not be overlooked that the element of cost in the maintenance and care of aluminum construction and the length of life are not well determined and are difficult to evaluate on account of the limited experience.

The results arrived at are thus to be taken in connection with the limitations necessarily imposed by the fact of the field being essentially new.

In summation, and in conclusion, aluminum has incontestable virtues as a structural material. Its great elastic elongation and resistance within the elastic limit places it far ahead of steel for resisting usual, well determined and repeated dynamic forces, while its great comparative lightness marks it for marine construction. On the other hand it has serious defects. An excessively low elongation beyond the elastic limit unfits it entirely for use where liable to be subjected to violent and unknown dynamic forces; temperatures beyond atmospheric undermine its physical properties; while, notwithstanding an innate superior resistance when pure to the attack of corroding agents, the high position on the electro-chemical scale causing excessive tendency to galvanic action, places a severe obstacle in the way of adoption where exposed to salt water and spray, particularly in the case of alloys, in which form alone the metal exhibits its best physical properties. This last serious defect, however, must be considered as subject to constant amelioration with increase of knowledge and experiment in precautions and higher perfection in manufacture.

Thus, while this new metal has an important field in marine construction, an important field now ready for occupation, and additional fields awaiting only the improvement in conditions for resisting galvanic action, these fields are essentially limited, and the larger domains are shut out by impassable barriers.

The early optimist who inferred all virtues from a single virtue, and the later reactionist who pronounced general unfitness from a few partial trials, were both wide of the mark. The metal is not utopian, but it has nevertheless beyond question an important mission for the serious marine architect, who is only waiting further improvement in manufacture and reduction in cost and further amelioration in conditions of corrosion.

For the naval architect of our own country, for our country itself, the question has a special significance.

The maintenance of a strong commissioned naval force must be our country's policy for taking its destined part of international greatness in regulating the common affairs of the planet, but our position and the spirit of the nation mark our naval policy specially for a great force kept economically in reserve, commissioned only periodically for drill purposes.

In a state of reserve the conditions of corrosion are greatly ameliorated. The vessels seek and lie in fresh water; the torpedo-

boats and small boats, which do not seek fresh water, are hauled up under sheds. Under these conditions the great obstacle of corrosion is largely removed from aluminum's path. Indeed, aluminum appears to be superior to steel in the resistance to the corroding effects of atmospheric exposure and of fresh water.

The question becomes more significant where account is taken of the great natural facilities and possibilities of our coast line for fresh water basins of large expanse for taking vessels of all sizes. It takes on a still more significant aspect when it is recognized that nature in the inland routes along the coast has marked small craft as our great second line of defense, while, in the inland waters of great rivers and great lakes in communication with the sea, she has provided immeasurable possibilities for the construction and maintenance of these craft.

Torpedo-boats which are thus marked for a great natural economical branch of national defense form now the least developed arm of our navy.

There therefore lies ahead, inevitably, a vast programme of torpedo-boat construction, for which every advantage of materials of construction should be earnestly sought. Fortunately for the nation this branch of defense admits of rapid growth and may be expected to have large expansion in the near future. Indeed, the time is not very far distant when, with treaty restrictions abrogated, we shall see on the great lakes, vast flotillas of torpedo-boats, lying for most of the year in economical reserve free from corrosion. Periodically, they will be commissioned for drill purposes, and from time to time will sally forth to the seaboard for mobilization and exercise in the operations of coast defense.

We would realize thus, at a minimum cost and a minimum turning away of the nation's energies from the channels of production, a great power, tranquil in time of peace and good will, irresistible for defense in time of war.

(*Discussions are requested, to be published in No. 84.*)

DISCUSSION.

Torpedoes in Exercise and Battle.

Lieutenant H. C. Poundstone, U. S. Navy.—Part of the data given in the essay is covered in "Notes on Care and Handling." The notes and suggestions on care, handling, adjusting, and practice, already formulated and in manuscript at the Torpedo Station, would, if published for the information and guidance of torpedo officers, be of the greatest assistance. The essay, in a great measure, furnishes a substitute for the notes, etc., referred to, and is a valuable contribution to the literature on the subject of torpedoes and their use. It is to be regretted that the writer did not more closely follow the standard service nomenclature.

I agree thoroughly with the writer as to the necessity for instruction of officers in the mechanism and use of torpedoes, and of more frequent practice to enable officers to gain familiarity and confidence in the use of this weapon; for, as the essayist states, something is learned from each shot, if the conditions and results are fairly analyzed; and the fact that torpedoes exhibit vagaries, apparently inexplicable, should be no bar to their use, for the percentage of hits, within their range, will more than favorably compare with gun fire. The question of cost should be obliterated, not, however, neglecting due precautions in handling, adjusting, etc.

The whole question of torpedo practice, as to adjustments, discharge, dive, set depth, speed, range, deviations, deflections due to speed, and abnormal performances, is in hand at the Torpedo Station for solution, and we shall doubtless soon have the results of practice, up to date, published for the information of the service.

The sections of the essay on "Battle Practice" and "Torpedo Boats and Drill Ground" are well thought out and should have serious consideration.

I congratulate the essayist on a most intelligent comprehension of his subject, and trust that the points to which he calls attention will be taken to heart by the service at large and by those in authority.

Lieutenant R. C. Smith, U. S. Navy.—Lieutenant Ellicott's essay on Torpedoes in Exercise and Battle must strike every reader with its valuable suggestions. A great deal of it could well be embodied in a manual of torpedo instruction for issue to the service. I believe such a work has been begun at the Torpedo Station. At any rate there is much "copy" available in the shape of reports of boards, torpedo-boat officers and others. I recognize a good many points in the essay that exist in that form and that well might be more widely known.

His point in regard to the occasional loss of torpedoes in exercise is certainly well taken. The Indiana has just held a gun practice which must have cost in the neighborhood of $15,000, or approximately the price of four to seven torpedoes according to the Mark. This number

would hardly be lost in a cruise with constant exercise. I do not agree with him that every torpedo in the ship should be used for practice. After many runs all bearings and connections become loose and the accuracy is greatly affected. Each torpedo should be kept carefully adjusted and given a run once or twice a year for verification, but for the ordinary practice I think it would be better to select a few torpedoes from the allowance and use them exclusively. The exercise is more for the practice of the torpedo division than to test the torpedoes, and for this purpose old torpedoes answer perfectly well.

The rules for adjustment on page 418 are those ordinarily given. There is one point that is not generally noticed, and I do not know that it has been formulated; but when once made plain, it aids very much in all the rudder adjustments. In following the rules the natural impulse is to start from forward and work aft through the various connections to the rudder. This is like pouring water through the small end of a funnel. When you reach the rudder you often have to go back and change the corrections already made, as each subsequent correction changes those ahead of it. By reversing the proceeding and adjusting the length of rudder rod first, then the valve star, the locking star and the rest, when you get to the hydrostatic piston the work is finished.

I am in entire accord with Mr. Ellicott's suggestion as to holding torpedo practice at sea in deep water. With the exception of a few cases of "running away," and one of leaving out drain plugs—not counting those of firing with negative buoyancy, which is never necessary—all the accidents I can recall have come from striking bottom or sticking in the mud at the bottom. As far back as 1880 an English board, in considering the desirability of adding a buoyancy apparatus to raise lost torpedoes from the bottom, decided that if the practice was held in deep water, in nine cases out of ten, the torpedoes not being able to strike the bottom, would not be lost.

If the practice must be held in shoal water, it may be desirable to have one or two of the torpedoes fitted with a recovery apparatus. The writer experimented with one at the Torpedo Station a couple of years ago, depending on the release of a buoy and line from the torpedo a few minutes after firing. The experiment went far enough to show the scheme to be feasible. I think the torpedo outfit should include a small air pump and gauge to test for air-tightness, such as is now in use at the Howell testing station; and were I in charge of a plant I should make requisition for one at the earliest moment. The drain holes in the Whitehead are a good place to make the connections, and they were so used lately aboard the Cushing.

On page 429 the probable deflection is given as about 1° per knot of speed of the firing vessel. Later experiments show that 2° is a better estimate for the short Whitehead torpedo and ½° for the Howell. If the Obry gyroscope, now in use abroad and which is being experimented with in this country, realizes expectations, the question of deflection can be eliminated from the mind of the torpedo officer.

The suggestions for simplifying the Whitehead torpedo made on page

431 might be given a trial. It is well, however, to bear in mind that many bright people have been working at the Whitehead for thirty years, and that the first presumption should oppose minor changes. Of course the torpedo is improving all the time, and *some one* must think out the changes. Consequently, all those that seem of sufficient merit should be given a trial.

In regard to the installation of torpedoes, as discussed on page 438, Mr. Ellicott arrives at the almost unanimous conclusions instanced by foreign practice. Let us by all means take up under-water fire. From all accounts it is by far more accurate, and no one can doubt its greater tactical value.

His conclusion as to control of fire—not by the captain, but by responsible persons at observation posts—is also accepted everywhere. Our own sighting arrangements are designed entirely on that principle, except in the case of the bow torpedo, if there is one, which is fired from the conning tower. Probably no more bow or stern torpedoes will be installed. They are even now being removed from ships which had them.

I do not agree with the views of the essayist on page 440 as to the desirability of installing torpedoes aboard cruisers and gunboats. These vessels should be built for one purpose alone, should have a light battery and as much speed as possible, and should not be hampered with extra weights and fittings of no ordinary utility and of possible use only in emergencies little likely to arise. In most cases the fittings would be shot to pieces before there was any chance to launch the torpedoes. Has the essayist considered the ethics of destroying merchant vessels by torpedo fire?

The discussion as to a torpedo-boat depot and drill ground, beginning at page 441, is the very best thing on the subject that I have chanced to see. I cannot think of a requirement that is not noted among those he mentions. And I do not see how there can be any escape from his conclusions as to the general locality to be selected. Surely after this discussion it would seem beyond reason to establish a station at either Boston or Newport. The only possible claim these points can have is that plants now in existence can be utilized to some extent and that they are near centres of labor. At any place selected, even Boston or Newport, sheds and launching ways would have to be constructed, and this would be a large item of the expense. Laborers can be obtained at any point where there are steady employment and fair wages.

In the programme of exercises on page 444 it does not strike me that torpedo-boats should be used to work out general tactical and strategic problems, simply because there will be no time for such work. Torpedo work and torpedo tactics will occupy every particle of time that may be available. For the same reason I do not believe they should be employed in reconnoissance of harbors and interior waterways, except for their own use, which is of course very important. The whole interior waterway system should be thoroughly developed and charted on a scale suitable for torpedo-boat navigation. For the preparation of plans of defense and war charts under the War College, I should think the college could ask

for and obtain two small light-draught vessels designed expressly for such use, which, with larger quarters and deck houses, would be in every way better adapted for the purpose.

THE CONSOLIDATED MESS OF THE CREW OF THE U. S. S. INDIANA.

Lieutenant-Commander E. B. BARRY, U. S. Navy.—I have read with great interest the paper by Lieutenant Decker on the consolidated mess of the Indiana. The idea is a very good one. Everything tending toward consolidation in internal affairs aboard ship is a step in the right direction, provided it does not go too far. I think, however, if the chief petty officers are exempted there is no reason why the first-class petty officers should not be; it would help to maintain the distinction between them and the ship's company, and after all would be only one more mess.

In connection with this subject is that of a beer canteen. I am not a "water drunkard," but I believe in real temperance, and I have yet to see any good results coming from a beer canteen. It is almost impossible to prevent doubling, and many men get loggy with beer, the taste grows, and where one day one bottle was sufficient, next week two will be hardly enough.

I do not ascribe the murder of the Indiana's master-at-arms directly to the canteen, but the probabilities are it would not have happened if there had been no beer about.

I look upon a regularly instituted beer canteen, especially when cargoes of beer are carried about from port to port, as injurious to the *morale* and discipline of a man-of-war.

It is the entering wedge to undo the grand work of the late Flag Officer Foote and others, who saw the evils of the spirit ration and succeeded in abolishing it. I trust most devoutly we never shall return to the condition of affairs existing before 1860.

Whether the mess can be maintained on a foreign station is yet an unanswered question. The difficulties are greater than at home, but I can see no reason why they should not be overcome. If a satisfactory solution is reached abroad, perhaps the consolidated mess may become part of the Department organization.

In my opinion the best man to have charge of the funds would be the ship's paymaster; the commissary yeoman would fall naturally under his direction. I repeat that the idea is a very good one and warrants general trial. If it works under all conditions it should be adopted as the Navy system.

Lieutenant-Commander DANIEL DELEHANTY, U. S. Navy.—I have read with pleasure Lieutenant Decker's paper on the consolidated mess of the crew of the U. S. S. Indiana. The subject is one concerning which I have been deeply interested for many years past. It has long been my opinion that the system in vogue for messing the men in our ships is faulty in the extreme, as bad a one as could be devised for all concerned.

About eleven years ago, while executive officer of the receiving ship Independence, Mare Island Navy Yard, under Captain Frederick Rodgers, I had the honor to put in successful operation the first consolidated mess. Like all innovations, it at first met with considerable opposition, but after a month or two the advantages were so manifest to the men in the better character of the food, its superior preparation, economy, cleanliness and adaptability, that all opposition ceased and the men willingly conceded that it was the only satisfactory way for them to mess on board ship, and the Independence mess is to-day operated exactly as it was ten years ago.

I have always believed and advocated that the system is wholly practicable for sea-going ships as well as for receiving ships, and that the proper way to run them both is on identically the same lines.

Nothing tends more to the contentment and comfort of a ship's company than a satisfactory commissary, and I believe the true way of accomplishing this is by the adoption of the system outlined.

On the first of last June the single mess was formed on board this ship under my personal supervision, with five cooks, the total number of men in the mess being three hundred and forty-five, which includes the entire crew excepting the officers' servants.

A temporary pantry was established on the gun deck abreast the galley. Two of the cooks were assigned to this pantry to prepare the food for the galley and to distribute it afterwards to the mess attendants; three of the cooks were stationed at the galley to attend to the cooking. A commissary yeoman was designed to select and order the supplies, a petty officer and a non-commissioned officer of the Marine Guard were named to advise with the yeoman and to certify to the correctness of the bills.

Under authority of the Navy Department one-half the number of rations were commuted. The practical results at the end of the month were that the men lived considerably better, the character and preparation of the food were greatly improved, and, barring miscalculation of the quantity necessary on several occasions, the men were clearly well satisfied with the experiment. No one had to contribute a cent to the maintenance of the mess, while the contributions from individual messes before that time varied from two to five dollars per month for each man. At the end of June the mess, however, was found to be in debt sixty dollars. For the month of July the number of commuted rations was increased to three-quarters of the whole, and at once a decided improvement in the mess was the result, with a surplus at the end of the month of one hundred and ninety dollars; this, after paying to each of the five cooks ten dollars, which, in my opinion, is an equitable, wise and satisfactory arrangement, as it stimulated the cooks to the best performance of their duties.

On the first of the present month the commanding officer directed the reduction of the commuted rations to one-half until such time as the Department may authorize an increase.

With all my experience in the conduct of this system of messing, I am unqualifiedly of the opinion that all rations should be commuted. It may appear to those who are not fully conversant with all the conditions that this would be a radical and dangerous experiment, but I am clearly of

the opinion that it would be otherwise. No more room would be required than under the present system; very little, if any, more provisions would be brought on board independent of the paymaster; most of the staple articles, such as pork, flour, sugar, beans, tea, etc., will be drawn from the paymaster and paid for at the invoiced prices, all of which would be an advantage to both the crew and the Government.

The system is so well established and so popular on board this ship, and, I believe, also on board the Indiana and Massachusetts, that I am convinced that it is only a matter of a short time when it will be extended to all vessels in the Navy.

There is undoubtedly room for improvements, and with such made, the system will be satisfactory and conducive to the comfort of the crew; the number of desertions will materially decrease, and the men will look upon their ship as in reality their home. I believe I am fully justified in this observation, as the system has been conducted on board under my personal attention and I have carefully noted the results, and the most important one is that since the inauguration of the mess on board, desertions from this ship have decreased more than fifty per cent.

I would strongly advocate—

1. That hereafter the system shall be uniformly conducted on all ships adopting it.

2. That a part of the ship near the galley shall be set apart for a commodious and properly constructed pantry, with a sink, draining overboard, for the washing of cooking and pantry utensils, with an adequate supply of running fresh water; bins of sufficient capacity for the daily supply of flour, sugar, coffee, etc., and that a bread bin be built near the pantry similar to the one used on board this ship, the bottom of which is a movable grating, to accommodate one or more days' supply of bread, with a false bottom below from which to clean the bin when filled.

3. That the practice of permanent seats at the table be absolutely prohibited. This is important, otherwise there is a great tendency for cliques, which exist in all ships, to seize certain tables as their right and to demand, or procure by other means, a discrimination in their favor at the expense of the more tractable men in the crew.

4. That all rations be commuted. If the Navy Department will consent to this it will unquestionably contribute to the success of the mess. In its operation at present a considerable quantity of the drawn ration is wasted, as the men will not eat it, and it is eventually thrown overboard or returned to the paymaster, the value being lost to the men and nothing is gained by the Government.

In conclusion I wish to say that during the latter part of last month this vessel was assigned to the duty of taking on board part of the New York Naval Militia for one week's instruction at sea and in port. Before the men came on board the commander of the division called on me to make arrangements for their subsistence. He stated that the state allowed each man forty-eight cents per diem for this purpose. I told him that they could be subsisted on board in a satisfactory manner for thirty cents per day, but he urged that his men were used to better fare than they were

likely to receive on board ship and he desired to make arrangements for the additional supply of food. I suggested that our commissary be given a trial first, and on this understanding his men came on board, remained a week, received the same fare as the ship's company, did not expend one cent for additional food, and left the ship loud in the praises of the mess.

I am a firm advocate of the system under discussion and believe it will come to all ships to stay, and will bring and keep in the service a superior class of men.

Captain C. M. CHESTER, U. S. Navy.—There is no question but that the crew of a ship, save perhaps the 1st class petty officers, should be in one mess, and that the food should be prepared by two, three or more cooks of a much higher grade than those that heretofore have been found as a part of the complement of our ships of war.

The assistants, under the direction of the head cook, should prepare all food for the ship's company, in the same way, and serve it to the messmen or waiters (erroneously styled berth deck cooks) for distribution to the crew.

I am totally antagonistic to the plan of commuting rations and purchasing food to suit the tastes of individuals, for it would seem to me this matter should be controlled by the highest authority. The paymaster, who is the commissary of the ship, as far as Government supplies are concerned, should take charge of all purchases for the crew, and not have a part of them furnished by him and the rest by a line officer detailed for the purpose.

The messing should "have the personal interest and assistance of the executive officer," as is required by regulations.

The rations should consist of plain, wholesome food as at present provided for issue at sea, and as a change, a suitable variety of fresh provisions in port; these should be strictly defined by regulations, to be made, however, elastic enough to take in the market of the port visited and the season of the year.

The commanding officer of a ship, or when in squadron, the commander-in-chief, should direct the purchase of "harbor rations" as may be required, in the same manner as provided for other Government supplies. When the ship goes to sea, as well as on two or three occasions during the week in port, as preparatory for sea service, the ship's company should be put on sea rations, with such small additions of vegetables as the present regulations contemplate; the whole idea being that the supplies of food, like all other supplies, should be under the direct control of the commanding officer. He then would be prepared, at all times, to move his ship at short notice for any service that may be required of him and for which he may not be able to make any special preparations.

What would become of the Indiana plan if that ship was suddenly ordered to watch an enemy's port, or sent under secret instructions, of which no information could be given to any one?

Why should a coal bunker be used for an issuing room for extra supplies when the ship is already deficient in coal endurance?

Any of us might say, "I never lived better in my life" by taking our meals at Delmonico's or some other famous hostelry, but the question we must consider is, what would be the effect of such living on the physical condition of men who are being educated for the struggle of battle.

If the food the Government provides is not suitable, let us make a change; but let us do it without sacrificing the principles of military control.

Frequently the Newark, during her last cruise, was required to proceed to sea upon telegraphic instructions, which did not permit laying in of supplies, and once she remained at sea for a month without other than sea stores.

Another strong objection to this messing system, to my mind, is its associations with a canteen, "started for the serving of beer, the profits of which went towards bettering the food that could be furnished."

The profits from this unwholesome traffic amounted to $3000 on board the Indiana, but from whom was this large sum drawn? The men themselves furnished it, and it is hardly probable that they would have been willing to have this tax levied upon them save that through it they were enabled to procure more beer; and their demand for an increase has added to the quantity which was at first allowed (one bottle per day), to three and four at the present time.

The fund could easily be doubled by increasing the allowance of beer, or money could be made for the mess by allowing the apprentices to join the beer club, which happily has thus far not become a common practice.

A number of years ago the whiskey ration, owing to popular disapproval, was abolished by an act of Congress; since that time the moral tone of the Navy has greatly improved, and yet recently we have gradually introduced a beer ration that not only contains more alcohol, but which (physicians tell us), taken with the other ingredients of beer, is the most baneful beverage that man can drink, enervating the system and debasing the moral senses.

It is pointed out by those favoring the use of beer in the Navy that drunkenness has decreased since beer was allowed and it is due to this cause; but I claim that this beneficial result is owing to a growth in moral sentiment among the men and is in spite of this handicap.

There are few ships, in my opinion, where grave breaches of discipline cannot be traced to the beer ration, and I wish the messing system, whatever it be, could have this prop taken from under it.

Lieutenant W. F. Fullam, U. S. Navy.—It is fortunate that the Navy Department and the Naval Institute are alive to the necessity for an improvement in the system of messing the enlisted force on board ship. The present indications are that a plan will be devised which will give satisfaction to the men and greatly improve the efficiency of the ship.

In this connection it may not be amiss to consider the following statements and suggestions which have been made in a most respectful and subordinate manner by an intelligent petty officer serving afloat:

"On board this ship we have twenty messes and it takes twenty cooks and eight assistant cooks to run them. A sum of $400 is paid monthly by the messes to these men for cooking.

"Of course every officer in the service knows that much the same state of things exists on board other cruising ships. They are aware of the waste of money in paying cooks, the exorbitant prices charged by bumboats, the frequent occurrence of runaway caterers leaving their messers hungry for a month or two, and how hard it is for a 3rd class apprentice to contribute monthly to his mess.

"Under the present system the bumboat is a great source of expense to the men. The following table will show the difference in prices charged for certain articles ashore and by the bumboat in the port:

	Bumboat.	Groceryman ashore.
Potatoes, per 100 lbs.	$1.60	$0.85
Eggs (100)	1.32	.88
Milk per quart	.10	.05
Milk, condensed	.20	.15
Scrubbing brushes	.35	.25
Tooth brushes	.25	.15

"The men could be saved a great deal of expense from bumboats if certain articles such as writing paper, ink, toilet soap, towels, etc., could be purchased on shore and a small space allotted to them on board ship (a U. S. Army canteen on a small scale). Reasonable prices could be charged for these articles and the profits turned in for the benefit of the general mess.

"Men who have lived under Lieutenant Delehanty's messing system, which was applied with such success on board the Independence in 1889, believe that a similar system with certain modifications could be adopted on board cruising ships. By having a proper allowance of ship's cooks the men could be put in one mess with a competent caterer at its head. With one-half the rations commuted and by the adoption of a small canteen on board each ship, the profits of which should go to the mess, the men could live well without being obliged to contribute a monthly sum of money."

These statements merit attention.

The existence of a large surplus in the case of a general mess has caused some dissatisfaction. But this difficulty can be easily removed. If the mess accounts are squared monthly, a man who is detached from the ship may be paid his proportional share of the surplus, and a new man entering may have the same charged against him, just as in the case of officers' messes.

Captain A. S. BARKER, U. S. Navy.—I have read Lieutenant's Decker's article on "The Consolidated Mess of the Crew of the Indiana" with interest. Whether or not the system will prove as efficient as the present method of messing, under all service conditions, can be determined by further trial.

I do not understand that the "canteen" is necessarily a part of the system; if it be, I am opposed to it.

I neither believe in having canteens on board our men-of-war, nor in having beer brought alongside in boats to be peddled to the crew.

It is time drunkards were weeded out of the service, and in my opinion no custom should be tolerated which tends to promote or keep alive a taste for drink.

I know there is, or has been, a difference of opinion on this subject, but I think that many of the former advocates of the innovation are now convinced that its influence is pernicious.

For one, I wish the Navy Department could see its way clear to forbid the custom. It has never obtained on the U. S. S. Oregon.

CONTINUED DISCUSSION OF ESSAY BY DOHRMAN. (See No. 82.)

JOHN S. WATTERS, Comdr., La. N. M.—The paper of Mr. H. G. Dohrman contains so much that is valuable that it is hard to cover all the points in a brief discussion. That the facilities for educating officers who have had no nautical experience, so that they may be even theoretically posted on a small fraction of what an officer of the Navy is expected to know, are at present so meagre that but little progress can be made, probably every commanding officer who has himself served in the Navy will admit without argument. That it is impossible for officers at a distance from Newport to attend the War College or Torpedo School is another thing that admits of no argument. The officers of the Naval Militia are mostly men whose time is not their own and whose means are limited. What attention they can give to their militia organization is only during the evening and on Sunday, and it can scarcely be expected of the most enthusiastic man in the world that he shall give every evening and every Sunday; but it would take pretty nearly that to enable him to obtain a fair grasp of his duties. As for the commanding officer, so many minor details must necessarily receive his attention that it is impossible for him to give proper attention to the instruction of officers.

I agree thoroughly with Mr. Dohrman's plan of a detail of naval officers who would come prepared to deliver a systematic course of lectures, following a well considered plan, for the instruction of the officers of the Naval Militia. A few lectures would do more good than any amount of literature, which would not make anything like the same lasting impression. Further, no greater encouragement could be devised than the manifestation of such an active interest in the Naval Militia by the Department. A certain amount of preliminary literature of such a character as could safely be disseminated would enhance the value of the course of lectures.

Provision should be made by Congress for defraying the expenses of commanding officers, so that they can attend the War College and Torpedo School. The actual expenses of transportation and the pay of their

grade while on such duty should be allowed them. This should be paid out of the national treasury, as the Naval Militia organization is, to a certain extent, national in its character, and the instruction of the commanding officers is a matter of sufficient importance to warrant this trifling outlay. Those who could spare the time could thus avail themselves of the opportunity, which is now a matter of impossibility for most of them; while if the various State legislatures had to make such provision, it would be a long time before it could be accomplished, if accomplished at all. This may strike some persons as savoring of mercenary motives, but as long as commanding officers are not millionaires, as they undoubtedly should be, there is no other way for them to get the instruction which it is important they should have. It would be little enough recompense for their outlay of time, trouble and money in a worthy cause.

I offer this as a suggestion, as there is a great deal that could not be touched upon by the officers detailed as lecturers to the officers generally, and of a character which could not be printed, but which commanding officers should know.

The listing of all merchant steamers visiting the port during the year, and keeping up with the condition of her machinery, coaling facilities, supplies generally, machine-shop facilities, etc., of local towns, is legitimately within the province of the Naval Militia, as is also the reconnaissance work which has been so successfully carried out by the New York battalion; the only difficulty in the way being that, as nights and Sundays are the only time during the year available for devotion to such work, barring perhaps a week during the summer, progress will naturally be slow in this direction.

PROFESSIONAL NOTES.

THE PROTECTION OF WARSHIPS.

Writing in *Le Yacht*, M. E. Duboc deals with the use of cellulose on warships as a means of preventing the entrance of water through a shot-hole. When the matter was first investigated, very satisfactory results were obtained. The cellulose being compressed into cofferdams behind the plating, was found to swell after the passage of a shot, and completely close the opening to water. Many French ships were accordingly protected in this manner, but further experience then showed that the cellulose under the conditions named was liable to decomposition, when it lost its obdurating properties; and further, when set on fire it burned with a most pungent smoke. Owing to these drawbacks, the use of cellulose in this way was abandoned on French vessels, being removed where it had already been fixed. The battle of Yalu, however, has shown that, if the disadvantages named can be overcome, the method has much to recommend it. Thus if the Chinese and the Japanese boats are compared, it will be found that the latter, which were protected with cellulose, came through the ordeal of perforation by shell fire the more satisfactorily. Thus the Chinese boat Tshi Yuen, struck near the water-line by a large shell which let in the water below the armored deck, capsized and went to the bottom. A similar fate awaited the armored cruiser King Yuen. On the other hand, the Japanese Itsukushima was struck by a 6-inch shell a little below the water-line. The projectile passed through two bunkers and burst in the aft stokehold. Some fragments of the cellulose packing traversed were carried with it by the shell and burnt, but the coal did not take fire. The sea entering the breach caused the cellulose to swell and to almost completely stop further entrance of the water. Similarly on the Matsushima two shot-holes amidships were equally stopped up by the automatic plugging action of the cellulose. In view of these facts M. Duboc raises the question as to whether the French Admiralty did not act somewhat too hastily in their precipitate abandonment of the use of the material in question, the more especially as further experiments in the United States have led to its extensive adoption by naval authorities of that country. As regards another matter, M. Duboc states that the Japanese have made some remarkable experiments in connection with the best means of strengthening a hull against torpedo attack. Two hulls were prepared, each with an inner shell, the space between the two being in one case left empty, and in the other packed with bamboo. On exploding equal charges against the outer shell of each, the first-named hull had both outer and inner skins wrecked, whilst in the second case the inner skin escaped injury almost completely, though the bamboo packing was reduced to shreds.—*Engineering.*

NEW TORPEDO TUBE FOR JAPANESE BATTLE-SHIP FUJI.

The following is from the London *Times:*

After leaving Spithead, where she represented the Japanese navy during the review, the battle-ship Fuji proceeded to Portland in order to carry out her torpedo and gunnery trials. On Thursday, July 15, she left the roads and occupied the whole afternoon in running torpedoes from her new submerged tubes. Runs were made at various speeds up to rather over 16 knots. The success of these trials is an important matter, and the Fuji and her sister ship the Yashima are the only two foreign ships which for the present possess submerged torpedo tubes.

The late war between Japan and China taught the belligerents and the world at large the risk a ship ran in carrying torpedoes for above-water discharge, exposed as they must be (if kept ready) to the fire of the enemy. If either the air chamber or the gun-cotton charge be hit, an explosion which may well cripple or destroy the ship must occur. The Japanese Government, guided by this experience, determined if possible that their future battle-ships and large cruisers should be fitted for the submerged discharge. They therefore applied to Sir W. G. Armstrong, Whitworth & Co., Limited, for designs of an apparatus. This was got out, and the firm undertook to carry out experiments with models in order to study the question thoroughly. The Japanese Government were bold enough to order the submerged tubes without any experiments with real torpedoes to prove results, and it must be most satisfactory to them to find they possess submerged tubes which are in every way satisfactory and in many ways surpass the performances of the English tubes.

The Elswick tube is in nearly every feature a completely new departure. The ejection is preferably made by means of cordite, although compressed air or steam may be used. Cordite is simple to handle and possesses the great advantage over the other two systems of being always ready for use. Its introduction for firing torpedoes as well as guns must be considered as an improvement.

Another marked feature in the Elswick tube is the automatic return. With it it is possible to withdraw the men and close up the submerged torpedo room, after having prepared the tube for firing, as no further attention is required. Hours afterward it will only be necessary to press the firing key, when the guide or shield will instantly be forced out, the torpedo discharged and the shield returned, the three operations following each other in such quick succession that they only occupy a total period of about a second. This rapid ejection and return seem to get over the difficulty of vibration hitherto experienced with submerged tubes. The shield has not time to set up vibrations. Again, the rapid return helps to clear the tail of the torpedo from the shelter of the shield, and this probably accounts in some measure for the small deflection with which the torpedo is ejected.

The velocity of discharge of the torpedo from the Elswick tube when the ship is at rest is 50 feet per second. At a ship's speed of 16 knots the velocity is probably about 45 feet per second. These velocities are much higher than are used in the English system, and yet the maximum pressure on the torpedo does not exceed 30 pounds per square inch.

One torpedo only was used throughout the trials on board the Fuji. It was picked up each time, recharged and ejected again; yet at the end

of the day it did not show a mark or sign of ill-usage or strain. The tube was so easily worked that it was always ready to receive the torpedo long before it could be secured and recharged. On account of the small deflection the practice at a boat was excellent. The torpedo used was an 18-inch long torpedo made at Fiume.—*Iron Age.*

CYLINDRICAL WATER-TIGHT DOOR.

Mr. Kircaldy, of Glasgow, has invented and patented a new type of water-tight door which bids fair to eclipse, with respect to general utility and efficiency, many existing water-tight doors. To the bulkhead, where the door is to be fitted, is bolted a hollow cylindrical casing, with two doorways in its circumference; within this casing revolves a hollow cylinder with a doorway in its circumference. To pass from one compartment to another, when the ingress doorway is in a line with the bulkhead doorway, the passenger enters and stands on the bottom of the casing and revolves the hollow cylinder by hand until he brings the ingress doorway into line with the second bulkhead doorway, which permits of egress from the casing. The remarkable feature of this "double door" is that it is absolutely impossible to leave it open, as one door must be effectively closed before the other opens, thus complying with the recommendation of the Board of Trade's Bulkhead Committee of 1890. The revolving cylinder is hung on ball bearings, and it is easily brought into the position desired for ingress or egress. At the same time no gear, so familiar to other types of water-tight doors, is required; consequently no attention on the part of the ship's crew is demanded.—*United Service Gazette.*

TRIAL OF SIMS-DUDLEY GUN.

A trial has been made at the artillery range of Sir W. Armstrong, Whitworth & Co., Silloth, on Friday, of the Sims-Dudley powder pneumatic gun, which is said to be the only gun in existence by which high explosives can be fired by the use of gunpowder. This weapon, which was manufactured by the Sims-Dudley Defence Company, of New York, is of 2½-in. bore and weighs 270 lbs., or with carriage, 500 lbs. Its length is 10 ft., and from the muzzle to the end of the carriage 12 ft. Air pressure reaching to 6000 lbs. to the square inch being produced by the explosion, no air-compressing plant is needed, and the gun is a self-contained, complete weapon. It consists of three tubes, arranged side by side on the same horizontal plane, the middle and longest tube being the main barrel from which the projectile is sent upon its journey. The other tubes are connected with each other and with the main tube. It is worked by two men, and the method of loading and firing being simple, six rounds may be fired per minute. The cylindrical projectile is of the same type as that used with a dynamite gun, and when charged weighs 11 lbs. In the main body of the projectile is placed a 4-lb. charge of explosive gelatine; in the front end a 6-oz. charge of dry gun-cotton, and in the gun-cotton is a cylindrical case containing 30 grains of fulminating mercury. The ignition is effected by a mechanical fuse, and when the shell strikes the water or any other object, a steel ball within it is driven forward, owing to the sudden retardation, and, striking one or more per-

cussion caps, causes a detonation, which ignites a tube of slow-burning powder, and this communicates with the fulminating mercury and so explodes successively the gun-cotton and the main explosive in the shell. The trial, on July 9th, was conducted in the presence of Lieutenant Moe, representing the Norwegian Government (for whose benefit it had been arranged), and Mr. Smithson, from Sir W. G. Armstrong, Whitworth & Co., and the spectators were much struck with the capabilities of the weapon. The longest range at which the projectiles were thrown was about 1750 yards. The explosions were very great when the projectiles fell, and it was afterwards ascertained that they had made holes 6 ft. to 8 ft. in diameter and 4 feet deep in the soft, wet sand. The gun will be taken to France to be tried by the French Government, and afterwards, at the request of the Sultan of Turkey, it will be tested in the Dardanelles.—*Engineer.*

ENGLAND'S FLEET MANŒUVRES.

War between the two divisions of the Channel Squadron, stationed respectively the first at Lough Swilly and the second at Blacksod Bay, will be declared at midnight on the 7th of July. The area of operations is bounded by the arc of a circle drawn from Blacksod Bay with a radius of 350 miles extending from the point where this circle cuts the 52nd parallel of latitude to the point where it cuts the 7th meridian of longitude. From these points to the nearest land the parallel and meridian named become the boundaries of the area. Late in the afternoon of the 7th the Second Division will put to sea, leaving one cruiser behind to bring on the news that war has been declared. This cruiser will leave Blacksod Bay at midnight and steam direct to a rendezvous prearranged with the battle-ship squadron of the Second Division. The position of this rendezvous is unknown to the other side, but cruisers of the First Division, presumably the Powerful and the Terrible, will be allowed to leave Lough Swilly in the course of the 7th and to take up positions north and south of Blacksod Bay by the time that war has been declared. These cruisers are not to attempt to follow the Second Division on its exit from Blacksod Bay, nor the cruiser which leaves later, but they are to wait near the coast until a specified time after war has been declared. At an early hour on the 8th inst. they are to proceed at a speed of 17 knots to search for the hostile cruiser, assuming that she has steered to the westward of them in a constant but unknown direction at a uniform speed of 12 knots. If either of them sights her she is to endeavor to escape, and for this purpose she will apparently be allowed to use her utmost speed, and if it should seem expedient to change her course if she is overtaken, she is required to inform her pursuers of the rendezvous for which she is making, and if she is put out of action under the rules she must return to Blacksod Bay and take no further part in the operations. In the meanwhile, the admiral in command of the First Division is empowered to send his remaining cruisers out to scout as soon as war is declared, but may not quit Lough Swilly with his battleships until the next day. The admiral of the Second Division will wait with his battle-ships within fifteen miles of his rendezvous until his cruiser has reached him, or, if she has failed to reach him, from daylight on the 9th instant until daylight on the 10th; but if during that period he is warned by his cruisers of the near presence of his adversary's battle-

ships he may endeavor to evade their pursuit. Subject to these conditions his object is to evade his adversary and to return to Blacksod Bay, the corresponding object of the First Division being to discover the whereabouts of the Second Division and to prevent its return to Blacksod Bay, and this object being adjudged to be accomplished if the battleships of the First Division have at any time got within three miles of those of the Second Division before the latter have reached a point ten miles from the entrance to their port. The operations will in any case be brought to an end at six o'clock in the afternoon of the 11th, ninety hours after the declaration of war.

It will be seen at once that the main stress and interest of the operations will center on the proceedings of the two cruisers told off to search for and intercept the hostile cruiser which is to leave Blacksod Bay at midnight on the 7th and to carry the news of the declaration of war to its own fleet at a rendezvous unknown to its adversary. If both these cruisers fail to accomplish their purpose, the task assigned to Admiral Stephenson will be reduced to that of looking for a needle in a bottle of hay, but their prospects of success are not inconsiderable under ordinary conditions of weather. The problem to be solved by them is as follows: A ship, *A*, leaves a certain point at an hour which is known and steams at a speed which is known and constant, but in a direction which is unknown save that it lies somewhere in an arc of 180°, of which the center is the point of departure. At each successive hour after her start *A* will be found on some point of an arc of which the center is her point of departure, and the radius the number of miles she has traversed at her known hourly speed, in this case 12 knots. Some hours after she has started, two other cruisers, *B* and *C*, each having a speed of 17 knots, start in pursuit from two points on the diameter of the arc equidistant from its center. From the geometry of the case it is manifest that their courses will be symmetrical, and, therefore, only one of them need be considered in detail. Obviously, if *A* pursues a course which brings her within sight of *B* before the latter starts, *A* will be intercepted within a few hours of her departure, but if she pursues a course slightly more divergent, *B*, when she starts, must shape her course so that it intercepts that hypothetically assigned to *A* at a point to which their known speeds will have brought them simultaneously. If the course hypothetically assigned to *A* should turn out to be the one actually pursued by her, the two ships will meet at this point, and in any case it is certain that when *B* is at this point *A* is somewhere on the arc of the circle hypothetically, and so far as *B* is concerned, on the quadrant, of which the center is *A's* point of departure and the radius a line joining the point reached by *B* to the center. Thenceforward the hourly distance covered by *A* and *B* will be twelve and seventeen miles respectively, and if at each successive hour *B* alters course so as to cut through the arc on some point of which she must be found, she will, when she has traversed the whole quadrant, have steered throughout a series of points, some of which *A* must have traversed simultaneously if her course lay in the quadrant at all. Precisely similar reasoning applies to the course of *C*, who will traverse an exactly similar curve in the other quadrant of the semicircle in which the course of *A* must necessarily be, so that, geometrically speaking, it would seem to be certain that *A* must be intercepted by either *B* or *C* at one point or another in the two courses traversed by them which lie symmetrically disposed in relation to the line which divides their respective quadrants.

The course thus indicated as that to be pursued by *B* and *C* respectively is called the "curve of search," and its geometry is explained in a paper issued with the instructions relative to the manœuvres. The curve of search is a device elaborated by two French naval officers, and the system on which it is based is very fully expounded in a volume entitled "Essai de Strategie Navale," published a few years ago. Geometrically it is unimpeachable, but its success in practice must manifestly depend not only on very favorable conditions of weather and navigation, but on an accurate knowledge of the speed and course of the pursued, and an equally accurate adapting to it of the speed and course of the pursuer, conditions not very often likely to be combined with adequate precision in the varying circumstances of actual warfare. However, as the art of scouting with modern warships is still almost in its infancy, it is perhaps worth while to try an experiment based on this geometrical method. If it fails to solve the problem propounded in the forthcoming manœuvres, its practical value for the real purposes of war will be largely discounted, because it is very unlikely that in real war the speed of a hostile cruiser would be accurately known to its opponents, or that such a cruiser would neglect the very obvious evasive expedient of frequently altering her course as well as her speed, and because the whole success of the method depends on the accurate appreciation and adjustment of the geometrical conditions involved.

The rules and regulations to be observed by the two opposing divisions of the Reserve Squadron during the manœuvres are as follows: The duration of "active operations" will extend from midnight of the 7th to 6 P. M. on the 11th instant. No hostile act may take place except during those 90 hours. Vessels at sea before the 8th are merely out in preparation. Battle squadrons cannot be divided, and must be intact at the moment of carrying out their object. The action assigned to cruisers is primarily, on the one side, to screen their battle squadron from observation, and, on the other side, to get touch with the opposing battle squadron in spite of its cruisers, and communicate with their own admiral. Cruisers can be put out of action according to the following rules: A first-class cruiser can put out of action a second-class cruiser if she can remain within a mile of her for 50 minutes, or a third-class cruiser if within a mile of the last-named for 30 minutes. Similarly, a second-class cruiser can put a third-class cruiser out of action if within a mile of her for 40 minutes. Two second-class cruisers can put a first-class cruiser out of action if they both remain within a mile of her for 100 minutes, and two third-class cruisers can put a second-class cruiser out of action if they are within a mile of her for 80 minutes. Some other combinations may be used, as for example, one first-class with one second or third-class cruiser can put a first-class cruiser out of action by remaining within a mile of her for 70 minutes, or one second and one third-class can disable one of the second-class by being within a mile of her for 40 minutes.

Provided, however, a larger group than two meet a group on the other side, it must be divided in order to act in accordance with the above rules. The period of action is to be between the two guns which the larger ship must fire to mark it. The first is to be fired when the two ships, in the judgment of the officer observing from the larger ship, are within the prescribed distance, and the second at the expiration of the time allowed. No other guns than those are to be fired. Cruisers put out of action under these rules can take no further part in the

manœuvres, but must return to their port flying the pilot-jack at the fore. They may select their own route, but they are strictly enjoined not to communicate any information as to the progress of the manœuvres to the ships of either side whom they may meet on their way. At the expiration of active operations, cruisers at the ports will carry out such orders as they have received relative to target practice and to their return to the ports of inspection. A copy of the ship's log and signal log of any ship taking part in the manœuvres, commencing 12 hours before and ending 12 hours after active operations, is to be sent to the Admiralty with the reports of the admirals in chief command. A board of umpires is to be formed in each fleet from the captains of battle-ships to decide upon the claims made by the cruisers of each division.—*Journal Royal United Service Institution.*

TESTS OF ARMOR AND SHELL.

[UNITED STATES.]

A most successful test was made at the Bethlehem Iron Company's testing grounds, at Redington, of a plate representing 650 tons of side armor for the battle-ship Kentucky, now being built at Newport News. Two shots were fired at the plate. The first was a Carpenter projectile weighing 500 pounds. A charge of 138 pounds of powder was used, generating a velocity of 1479 feet per second. The penetration was between 7 and 8 inches. No cracks were developed. The second shot was a Holtzer projectile of the same weight as the first, 500 pounds. A charge of 3230 pounds of powder sent it against the plate at a velocity of 1600 feet per second. The penetration could not be determined because the projectile was welded to the plate at the point of impact. No cracks were developed. This armor and also that for the Kearsarge were contracted for before the present agitation about the price of armor plate.

TURRETS OF NEW DESIGN.

Steel turrets of new design have been adopted by the Navy Department for use on the battle-ships Alabama, Wisconsin, and Illinois. They are the design of Assistant Naval Constructor Dashiell and are unlike those carried on any other warship. In the new turrets 13-inch guns will be installed, capable of a most destructive fire, and at the same time well protected from bombardment. The main features of the new turrets are vertical walls on the rear and sides and a sloping plate in front. The plates are of a uniform thickness of 14 inches, the front plates sloping 42 degrees to the horizontal. At such an inclination it will be almost impossible for any projectile to penetrate the plate, while the vertical plates would resist a 12-inch shot at 2000 yards' range. One of the chief advantages of the inclined plate is its deflecting qualities. It has been recognized that the necessity for keeping the turret guns trained at all times on the enemy opens the immediate front or exposed part of the turret to serious consequences, while, with a curved plate that will deflect the projectiles, it will be almost impossible to do the turret any great harm when the deflective parts are presented as the target.

CHANGE IN ARMOR TESTS.

Instead of firing at plates with ordinary armor-piercing projectiles, the new requirements permit the Department to use capped armor-piercing

projectiles if it be thought desirable. In addition the cracking shot is done away with, and the two shots, which the specifications require to be fired, are given the same velocity. Comdr. O'Neil, Chief of the Ordnance Bureau, holds that the cracking shot has never been of service. The velocity usually given a shell fired for testing the resistance of the plates with reference to cracks was very low, for an 8-inch plate, for instance, fired at by an 8-inch gun, being 1290 feet per second. What is commonly known as the perforation shot when an 8-inch plate was undergoing test and an 8-inch gun being used, was given a velocity of 1558 feet per second. The only result of the difference in velocities was to make the tests of the plate less severe than they should be. In the test of an 8-inch plate by an 8-inch gun, it is proposed under the new specifications to discharge two capped projectiles at the target with a velocity of 1404 feet per second, and when uncapped projectiles are used, to fire them with a velocity of 1564 feet per second. The new specifications require the use of a 4-inch gun in testing armor of 3 and 4 inches in thickness; a 5-inch gun for armor of 4, 5, 6 and 7 inches in thickness; a 6-inch gun for armor 5, 6, 7, 8 and 9 inches in thickness; an 8-inch gun for armor 8, 9, 10, 11 and 12 inches in thickness; a 10-inch gun for armor 10, 11, 12, 13, 14, 15 and 16 inches in thickness; a 12-inch gun for armor 13, 14, 15, 16, 17 and 18 inches in thickness, and 13-inch gun for armor 15, 16, 17 and 18 inches in thickness. When armor of the same thickness is liable to test by two guns, the Department may choose either caliber.

[ENGLAND.]

TEST OF VICKERS PLATE.

Messrs. Vickers, Sons & Co. (Limited) had a most successful trial of a 4-inch special nickel-steel armor plate on board the Nettle on July 20 under the direction of naval officers at Portsmouth. The plate was 4 ft. square, 4 in. thick, and had no wood backing behind. It was attacked by a 5-in. gun, Palliser projectiles. The first shot was fired with a velocity of 1406 ft. per second, but the plate showed no sign of having been hit. The 50-lb. projectile simply splashed on the face. The second shot was fired with a velocity of 1750 ft. per second, the plate being indented about three-quarters of an inch, but the face was not in any way broken. The third shot also had a velocity of 1750 ft., but the indentation was only half an inch. There were no cracks of any kind in the plate, but the projectiles were in every case broken to fine pieces. Great satisfaction was expressed with this result, as the plate will prove invaluable where thin, unbacked armor is desired.—*United Service Gazette.*

TEST OF BROWN PLATES.

Recently there has been considerable activity at the works of our armor plate constructors, with the view of improving the hardening process and the resistance of the plates, and quite a series of trials have been made on board the old Nettle at Portsmouth. Both plates were tested in the presence of Sir W. H. White, assistant controller and director of naval construction, and of the captain of the Excellent; the principal object of the trial was to determine: "(1) Whether the surface cracks that are liable to occur in manufacture in the case of the most modern plates are prejudicial to their resistance; (2) Whether a plate that has

Official Data of Messrs. J. Brown and Co.'s Armor-Plate Tried on July 20, 1897.

Description.				Point of Striking.	Effect on Front of Plate.	Result on Back of Plate.	Effect of Striking on Projectile.
Round.	Gun used.	Charge.	Projectile, if a Shell, Weight of Burster.				
1*	6-in. B. L.	E. X. E. 48 lb.	Holtzer A. P. 100 lb.	2 ft. from right edge, 2 ft. from bottom.	Size of injury, 13 in. by 10 in.; depth of injury, 2 in.; back of plate set back.	Size of bulge, 14 in. by 14 in.; height, 1¾ in.; semicircular crack on centre of bulge, and horizontal crack on top of bulge. Backing.—Size of indent, 14 in. by 14 in.; depth, 1⅛ in..	Broken up, point embedded in plate; point of core ⅜ in. in front of face of plate.
2†	"	"	"	2 ft. from left edge, 2 ft. from bottom.	Size of injury, 15 in. by 14 in.; back of plate set back locally; surface scaling around round 1; hair line from round 1 to round 2; point of projectile of round 1 jarred out.	Size of bulge, 13 in. by 13 in.; height, 1 in. Backing.—Size of indent, 13 in. by 13 in.; depth, ⅞ in.	Broken up, point embedded in plate; point of core 1 in. in front of face of plate.
3†	"	"	"	2 ft. from left edge, 2 ft. from top.	Size of injury, 15 in. by 13 in.; size of hole, 7 in. by 7 in.; edges of hole smeared; crack showing from round 2 to left edge of plate.	Size of bulge, 9 in. by 12 in.; height, 5⅛ in. Backing.—Size of indent, 9 in. by 12 in.; depth, 5½ in.	Broken up, remains of projectile remaining in the hole.
4†	"	"	"	2 ft. from right edge, 2 ft. from top.	Size of injury, 10 in. by 12 in.; back of plate slightly set back; hair line from round 3 to top of plate; hair line from rounds 1 and 2 developed; point of projectile of round 2 loosened.	Size of bulge, 10 in. by 10 in.; height, ⅞ in. Backing.—Size of indent, 10 in. by 10 in.; depth, ¾ in.	Broken up, point embedded in plate; point of core 1⅜ in. in front of face of plate.
5†	"	"	"	Delivered at a point where hair line was showing at centre of plate.	Size of injury 14 in. by 12 in.; surface cracks between rounds 1 and 5, and rounds 3 and 4; hair line from round 3 to top of plate developed; cracking to the right of and below round 1; vertical crack 15 in. long and 10 in. to the right of round 5; point of projectile of round 2 jarred out.	Size of bulge, 12 in. by 12 in.; height, 1 in. Backing.—Size of indent, 11 in. by 11 in.; depth, ⅞ in.	Broken up, point embedded in plate; point of core 1¾ in. from face of plate.

Remarks.—* M. V. 1960 foot-seconds. † M. E. 2663 foot-tons.

been machined to a smooth surface before supercarburization offers a better defense than one that has been carburized on the rugged surface as left from the rolls; and (3) whether a sort of fold, technically called a 'lap,' in the face of a plate causes a local or general weakness." It may at once be said that the results appear to show that the surface cracks did not affect the resistance at all, even when the shot struck actually on them. That the advantage of the tedious and expensive process of machining all over the surface might be considered as affecting alone the appearance and economy in paint—both points to which some importance is attached—and that a "lap" in the face may be a source of weakness if a shot strikes exactly on it, but does not affect resistance under any other conditions, nor does it conduce to cracking.

Both the plates tried—the latter on August 10—were 8 ft. by 6 in. thick, and were cut from a single larger one, which, after rolling, had been straightened and machined on one side to an even thickness of 6 in. The plate tested first—on July 20—had been supercarburized on the smooth side, and the other on the side that had not been machined. The subsequent treatment of the two plates was alike, and as the material was of a new and special kind, the manufacturers were not satisfied with making the plates flat in the first instance, as is usual with test plates, but made them originally concave, and then heated and bent them till they were slightly convex. This was done so that the plates might undergo all the processes that would be necessary if they were to form part of a ship's armor, every plate of which usually requires to be bent, and some very considerably, with the hard side in tension. In the case of the first (the smooth-faced) plate this bending produced some superficial cracks in the face, but in the other it did not. The second plate, however, had a seam where the steel had lapped over itself slightly in forging.

The most recent Admiralty requirements are that a plate of the dimensions given shall resist five Holtzer steel projectiles of 6 in. in diameter and 100 lb. weight at 1960 foot-seconds striking velocity, without serious cracking, and it will be seen that these conditions were satisfied in both instances.

The first of the plates was tested on July 20. All the shot were completely destroyed, and the penetration obtained was slight (about 2 in.) except in the case of the one that struck in the upper left-hand corner, which at first was thought to have just got its fragments into the backing. When the plate was taken down, however, this was found not to be the case. The disc of the plate immediately opposed to the shot had yielded to some extent as if it had been a door hinged on the left side which the blow had partly forced open, but not enough to expose the backing, or let any part of the shot pass through. The other impacts had merely raised slight bulges on the back of the plate, which was practically free from cracks. Some unimportant superficial cracks in the hard face were developed as the trial progressed, and one of these, from impact No. 2 to the left edge, appeared from the front to have gone through the thickness of the plate at that edge, but was traceable only about 2 in. deep when the plate was taken down. One of the superficial face cracks previously alluded to as produced in this plate at the bending stage of manufacture occupied a position in the center, and the fifth round was carefully aimed to strike exactly on it. It did not appear to influence the result in the least, nor did it, or any of the other original surface cracks, show any signs of extension during the trial. The official details of the trial are given in the above table.

The second plate, which presented its rough side to the attack, was tested on August 10. It displayed a "lap" running horizontally across its width through the usual positions of impacts 1 and 2 (but in this case of impacts 1 and 3). The first round was made to strike exactly on it, and the fact that this shot alone out of six got its fragments just into the backing, seemed to show that the plate along the actual line of the "lap" was weakened by it. The second round was fired at the center, and made, in common with all the other rounds, only a shallow indent. To determine whether the weakness caused by the "lap" extended beyond its immediate situation, the third round was aimed just to avoid it by about an inch, and from the result it was evident that the weakness was absolutely local, and that the "lap" had no tendency to produce cracking whether the blow was actually on it or very nearly so. Indeed, the face of the plate after the six rounds showed no cracking whatever beyond a few superficial hair lines, and it is to be expected that when its back is seen, it will show five slight bulges, one hole (where the "lap" was struck) and no cracks. The information derived from these two trials on the experimental points referred to is of considerable value, and the general result was very satisfactory.—*Engineering.*

Recent Armor Trials.

The hope recently expressed that we might shortly obtain results with armor plates which would show that the high standard achieved during the past year can be reckoned on for the future has been fulfilled more quickly than we could have expected. A fortnight ago an excellent result was obtained at Portsmouth by 6 in. plates submitted by Messrs. Brown, the plate being tested on supply, and in the *Times* of August 20 is a report on a much thicker plate made by Messrs. Vickers, tested at Shoeburyness on August 19. The dimensions of this plate were 10 ft. by 7 ft. by 11⅛ in. It was backed by 12 in. of oak, and it was attacked by three 12 in. steel Holtzer projectiles, each weighing 714 lbs. It was intended to fire two rounds with a striking velocity of 1850 foot-seconds and the third with 1800 foot-seconds; the stipulation was that no piece of plate or shot should be driven completely through the wood. The first shot, however, was actually fired with a striking velocity of 1861 foot-seconds, and broke in pieces on the plate with a penetration of only 2⅝ in., no cracks being formed. Round 2 struck with 1868 foot-seconds, breaking to pieces with 2¾ in. penetration and no cracking. It was then decided to fire the third round with 1860 foot-seconds striking velocity; this only obtained 2½ in. penetration, breaking up as before without cracking the plate. Thus it may be seen that the resisting power of the plate far exceeded what was stipulated for it. The perforation of the second round, theoretically by Tresidder's formula, was 23.6 in. of iron, which, divided by the actual thickness of the plate, gives 2.02 as the figure of merit of the plate, which is very excellent indeed. The energy per ton of plate of this blow was probably about 1157 foot-tons, supposing the plate to weigh nearly 15 tons.

This, then, is the very result we have been hoping to see in this country; that is to say, it is a magnificent result obtained with a thick plate. It may be urged that it has not broken the record, because Krupp's 11.8 in. plate still stands first with a figure of merit of 2.19, and a shock per ton of 1479 foot-tons. At the same time it is to be observed that it

cannot be proved that Krupp's plate was better than this, so far as we have data. It was certainly subjected to a test which was more severe, but as the Vickers plate entirely defeated the attack, it is probable that it would also have defeated the same attack as that to which the Krupp plate was subjected.

It is foolish, no doubt, to hazard an opinion on a plate which we have not seen, but we would point out that there is evidence that the resisting powers of the plate had evidently so far impressed the authorities that they acted with a confidence which, had it not been justified by results, would have embarrassed them. The first round was delivered with 10 foot-seconds higher velocity than was stipulated; yet the second round had a further excess of 8 foot-seconds, so that apparently no reduction in the charge was made; and the third round was delivered probably with the same charge with a striking velocity of 1860 foot-seconds, or 60 foot-seconds higher than was stipulated. It would have been awkward had this driven any metal completely through. So that it is clear that the behavior of the plate had put such a contingency out of the question in the judgment of those experts who witnessed the trial both on behalf of the Government and of the makers. It reads also as if the Vickers plate was one taken to govern supply pending the erection of proof butts on Whale Island; and if so, we must accord it credit on this account. In fact, it would be better to separate supply and champion plates, and accord this the credit of being the record "supply thick plate," while Krupp's is the record "champion thick plate." It may be observed that we are writing without the full information and data which we hope may be forthcoming by-and-bye, because we regard the trial as one of such importance as to deserve the facts which we have to be made known without delay. We should think that the figures given bear the stamp of accuracy, although we imagine that an important mistake has been made in calling the plate a nickel Harveyed plate. Messrs. Vickers have adopted the Krupp process, and have specially dwelt on its excellence for thick plates; it is extremely unlikely then that for this important test a Harvey process plate was submitted by them. We would again finally express the wish that we could try the powers of other projectiles besides those of Holtzer. He himself has protested against his 6 in. shot—delivered in 1889—being taken as a sample of what he could now supply, excellent as they were for their day. Cannot Elswick supply us with some of its Wheeler-Sterling shot? It is only fair to our own plates to forestall the objection which will naturally be made abroad to calculations based on our trials made with Holtzer shot only.—*Engineer.*

Test of Hadfield Projectiles.

Every Englishman should be glad to learn that Hadfield's armor-piercing shot have attained successful results. It is undoubtedly our duty to secure anything good for our Navy that may be developed abroad, but we must naturally be best pleased when home manufacture comes to the front. Hadfield stands in a unique position in the development of projectiles by English processes, for though long ago Firth made steel shot, and Whitworth for a time stood unrivaled, for many years past we have chiefly depended on Holtzer's shot, made abroad, and on projectiles made by Firth or Elswick on the Firminy process. The supply of English projectiles made wholly on English processes long depended, we

think, on Mr. Hadfield alone, though latterly Colonel Bainbridge has made excellent shot at the Royal Laboratory. To speak plainly, for a long period we neglected to encourage the manufacture of armor-piercing shot. Had it not been so, Whitworth would not have given it up. Our own Royal Laboratory was not allowed to make them, and for many years Hadfield, under great discouragement, pushed on experiments with cast steel and with steel alloyed in various ways, and latterly with shot with heads of different forms. We are now glad to give the following account of recent successful trials made with Hadfield shot: "Two 6-in. Hadfield projectiles, of special design and quality, and with caps on their points, were fired, with a velocity of 1960 ft. and 1940 ft. per second, at a large Harveyed steel plate 8 ft. sq. and 6 in. in thickness. The plate on its upper surface had before received two 6 in. forged steel shots, neither of which had penetrated more than about 2½ in. There remained about 70 per cent. of the plate area untouched and uninjured. In both cases the projectiles pierced the 6 in. plate and 2 ft. of wood backing, and were found 15 ft. to 20 ft. at the rear of the sand butt. Though broken, the wreckage and destruction of timber, bolts and fastenings caused by the projectiles were specially great, showing the considerable remaining energy they possessed after passing through the plate itself. If this had been on a ship's side the damage done would have been very serious, the broken portions, not one of which was found on the front side, acting as mitraille, as was proved by the shattered condition of the surroundings and the backing." A Hadfield 6-in. projectile was also fired against a 9-in. special steel and water-hardened Sheffield plate, which it perforated completely, being recovered unbroken 20 ft. in rear.

Strange as it may appear, we think more highly of the perforation of the 6-in. Harveyed plates than of the 9-in. plate, believing the latter to be probably of the same kind as has been perforated by a Royal Laboratory 6-in. shot. On the face of it, as our readers may see, the 9-in. plate which allowed the shot to pass through unbroken must be very inferior in quality to the 6-in. Harveyed, which, although perforated, broke the shot in their passage. The fact is that this is an illustration of what very great differences exist in the resisting power of plates, and how much is due to the precise effect produced by the Harvey or Krupp process. The difference between a tool with a broken point and an unbroken one is naturally very great, and this is what is implied in the action on the shot of a really first-class face as compared with one less good.

Taking the result on the 6-in. Harveyed plates, then, as the more trustworthy and severe test, we have a very good result. It is difficult to compare it fairly with foreign trials. In the United States Wheeler-Sterling shot have done apparently more, a year or two ago, and Hadfield's shot without caps obtained a good result at Portsmouth, but probably Harveyed armor has improved since then, or it would not be a great boast that a capped Johnson 6-in. shot had perforated a 7-in. Harveyed plate with some little deformation. We trust that we shall hear of continued success with Hadfield projectiles, not only on the maker's own account, but for the credit of our country.—*Engineer.*

SHIPS OF WAR.

[ARGENTINE.]

TRAINING SHIP PRESIDENTE SARMIENTO.

The navy of the Argentine Government is about to be strengthened by the addition of a vessel floated from one of the building docks at Messrs. Laird Brothers, Birkenhead Ironworks, on Tuesday, August 31. This ship has been specially designed by the builders for service as a naval training or school ship, in the carrying out of which the builders have been in constant communication with officers of the Argentine Naval Commission, of which at present Captain Don Onofre Betbeder is chief. The vessel is named the Presidente Sarmiento. The approximate dimensions are: Length, 270 ft.; beam, 43 ft.; displacement, about 2750 tons; her draught of water will not exceed 20 ft.

The hull is of steel, built with a double bottom, and very carefully subdivided into twenty-four principal water-tight compartments, with coal protection along the machinery spaces. The bottom is sheathed with teak to 4 feet above the water-line, and coppered. The stem, stern and rudder frames are of bronze. She has a clipper bow, a handsome stern with gallery and stern walk, poop, forecastle and steel plate bulwarks, the material and workmanship throughout being equal to the requirements of the British Admiralty. The accommodation is specially roomy and well ventilated, and the sanitary arrangements are of the newest type, and provided for a total number of 400, each rank having separate and specially allocated quarters. Workshops are provided for each class of midshipmen and apprentices, and are suitably supplied with machine tools, &c. She is full ship-rigged, carrying a large spread of canvas, as it is intended to do a great part of her cruising under sail; and in view of this she is fitted with a Bevis feathering propeller. The boat equipment, which includes two steam launches, is on an ample scale.

The engines are direct-acting inverted triple compound, driving a single feathering screw propeller of sufficient power to give a speed of thirteen knots per hour. The boilers are four in number, each pair being in a separate water-tight compartment with its coal supply; two of them are of the Niclausse type and two of the ordinary cylindrical tubular type, and in addition there is a separate boiler for auxiliary purposes. The distillers are of very large capacity and are in duplicate. The electric light installation is also in duplicate, whilst there is a powerful refrigerating apparatus and chamber. The armament, which is of the most modern type, Elswick and Nordenfelt, comprises five 4.7-in., two 14-pounder Maxims, four 6-pounders, four 3-pounders, and other subsidiary guns, as well as three torpedo tubes. The ammunition hoists are to be worked electrically, and all means of transporting ammunition and projectiles are of the latest type. There will be two powerful search-lights, as well as special system of signals.—*Engineering.*

[AUSTRIA.]

THE ZENTA.

The torpedo cruiser Zenta was launched at Pola, August 18. She is of the modified Panther type; built of Siemens-Martin steel, she is 315 feet

long, 38 feet beam, 14 feet draught, of 2326 tons displacement. Two triple-cylinder engines, Yarrow water tubular boilers, developing 7800 horse-power, giving a speed of 20 knots. The normal coal capacity of 472 tons permits a radius of action of 3800 miles at 12 knots speed. The armament to consist of eight 4.7-inch, 40-caliber rapid firers, and ten 47-mm. R. F. guns, two gatlings and two 18-inch torpedo tubes.—*Le Yacht.*

[ENGLAND.]

NEW CONSTRUCTIONS.

Messrs. Vickers, who lately purchased the Naval Construction and Armaments Company's works at Barrow-in-Furness, have secured the contract for the new battle-ship of the Canopus class authorized to be constructed in a private establishment under the naval programme for 1897-98. The dimensions of the new vessel are: Length, 390 feet; beam, 74 feet; width, 43 feet; and displacement, 12,950 tons, on a mean draught of water of 27 feet 6 inches. The broadsides are to be protected by a 6-inch Harveyized armor, composed of an alloy of steel, nickel and chromium. The armament will comprise four 12-inch 46-ton breech-loading weapons, mounted two in each barbette; twelve 6-inch 100-pounder Q. F. guns, mounted three on either broadside, two for direct fire ahead and two for direct fire astern; and twelve 12-pounder Q. F. guns, besides four submerged torpedo tubes for the discharge of Whitehead torpedoes. In the design of the vessel speed has been considered to be an important item, and engines of the triple-expansion type will be provided to develop 13,500 H. P. when running at about 110 revolutions. The engines will drive twin screws, and each set will have cylinders of 30 inches, 49 inches and 80 inches diameter respectively, with a stroke of 51 inches. The boilers, twenty in number, will be of the Belleville type, with economizers, the total grate area of the boilers being 1050 square feet, and the heating surface about 34,000 square feet. The new ship is to be called the Vengeance.

According to the statement of the First Lord in Parliament, the other three new battle-ships, which are to be built at Portsmouth, Chatham and Plymouth respectively, are to be Majestics of an improved type, bringing the number of that formidable class up to twelve. Their dimensions will be as follows: Length, 400 feet (10 feet more than the Majestic); beam, 75 feet; mean draught, 26¾ feet (9 inches less than the Majestic); with a displacement of 14,900 tons; their mean speed with natural draught is to be 18 knots, or 1½ knots more than the Majestic; and they are to have an estimated continuous speed in smooth water, with clean bottoms, of 16½ knots. The ship will be fitted with water-tube boilers, the coal supply and bunker capacity being the same as in the Majestic. Their armament is to be identical with that of the Majestic, but new and powerful types of 12-inch and 6-inch guns will be provided, and improved mountings will be introduced. The hull armor, or citadel, will be of the same extent and thickness as in the Majestic, but the quality of the armor will be superior. The armor is to be of nickel steel, and the quality is so superior that the protection, buoyancy and stability of the vessel will be sensibly increased. A new feature in these ships is that before and abaft the citadel armor the sides will be protected by thin armor, as in the Canopus class. The protection of the barbettes containing the 12-inch guns and the protection of the 6-inch Q. F. guns will be

equal to that of the Majestic class, and the arrangements for the stowage and transport of ammunition will resemble those of that class.

The new light-draught river gunboats are to consist of six vessels of 100 feet length, 2 feet draught, and a maximum speed of 9 knots; two vessels of about 145 feet length, 2 feet draught, steaming 13 knots; and four twin-screw river gunboats of 180 feet length, 8 feet draught, and a maximum speed of 13½ knots.

The general dimensions of the new Royal yacht are to be: Length between perpendiculars, 380 feet; beam, 50 feet; mean draught, with keel, 18 feet; displacement, about 4600 tons. The hull will be of steel, with minute subdivision into numerous water-tight compartments, and a cellular double bottom as an additional security, and for the purpose of maintaining speed at sea for considerable periods the steel hull will be sheathed with teak planking covered with copper. The vessel will be propelled by twin screws, actuated by vertical triple-expansion engines, and the maximum speed on the contractors' eight hours trial will be 20 knots.

Four new armored cruisers of quite a new type are also to be laid down, these vessels being in addition to the programme as already presented to Parliament; their dimensions being as follows: The length between the perpendiculars, about 440 feet; the extreme beam, 69½ feet; the mean draught with keel, 26 feet; and the displacement, 11,850 tons. Armament: two 9.2-inch guns and twelve 6-inch Q. F. guns, these being of a new and more powerful type; fourteen 12-pounder Q. F. guns, with a certain proportion of smaller Q. F. guns and two submerged torpedo tubes. The protection of the 9.2-inch and 6-inch Q. F. guns will be equal to that of the Powerful class, but the quality of the armor will be superior. Arrangements for the supply of ammunition will be similar to those in the Powerful and Diadem classes. Protection to the buoyancy and stability will be secured by vertical armor of the same thickness and quality as in the Canopus class of battle-ship. The protective decks will be similar to the Canopus class. The steel hulls will be wood-sheathed and coppered, so that the vessel may keep the sea for long periods without serious loss of speed. The measured mile speed, with natural draught, on an eight hours' trial, will be about 21 knots. Water-tube boilers will be adopted, and the continuous sea speed in smooth water and with clean bottoms will be about 19½ knots. The coal bunker capacity will be about 1600 tons, half of this being carried at the above-stated draught and displacement. All four ships are to be built under contract.—*Journal Royal United Service Institution.*

Warships under Construction.

In order to afford a comprehensive view of the shipbuilding in progress throughout the United Kingdom, the following statement of the war vessels which are at present under construction has been compiled. For this statement it has been assumed that a vessel may be regarded as "under construction" from the commencement of the laying of her keel to the time when she is ready for her steam trials. Of course, when this latter stage is reached the guns have usually still to be placed on board and the vessel to be fitted out before she is ready to be commissioned; but she is, nevertheless, structurally completed:

British.	No.	Displacement. Tons.
First-class battle-ships	8	109,450
First-class protected cruisers	8	88,000
Second-class protected cruisers	7	40,000
Third-class protected cruisers	7	14,945
Torpedo-boat destroyers	30	10,000
Total	60	262,395

Foreign or not stated.	No.	Displacement.
Armored vessels	6	49,380
Protected cruisers	7	27,870
Torpedo-boat destroyers	13	4,340
Torpedo-boats	6	750
Other vessels	1	2,460
Total	33	84,800
British and Foreign total	93	347,195

—*Steamship.*

Le Yacht, in commenting in its issue of July 3, 1897, upon the wonderful increase in England's navy, shows the following comparison between the reviews of Spithead in 1887 and 1897:

	1887	1897
Battle-ships	27	25
Large cruisers	none	12
Smaller cruisers	14	54
Gunboats	31	20
Destroyers	none	30
Torpedo cruisers	38	20
Personnel	15991	36565
Guns	441	2147
Total number of ships	110	161

A glance at the table will show the enormous increase in the number of cruisers; instead of the 14 cruisers present in 1887, we find 66 in 1897, and among the latter 12 armored cruisers of enormous tonnage, such as the Powerful and Terrible. Ten years ago England did not possess two cruisers for each battle-ship, to-day she has more than four cruisers for each battle-ship. France can only muster 1.6 light ships for each battle-ship.

The Panther.

Messrs. Laird Brothers, of Birkenhead, had, on the 4th July, a highly successful trial of H. M. torpedo-boat destroyer Panther on the measured mile at Skelmorlie. The vessel attained the highest actual speed yet recorded for the mean of six runs on the mile, namely, 30.52 knots; and for three hours' continuous steaming she maintained 30.16 knots. After the speed runs, steering, anchor, and stopping and starting trials were completed. There was no hitch of any kind. The vessel returns to Birkenhead for completion, and will shortly leave for Devonport Dockyard.

The Bat.

The Bat, torpedo-boat destroyer, built by Messrs. Palmer, of Jarrow, carried out her second stipulated three hours' 30 knots trial at Portsmouth on July 14th under the command of Staff-Com. Hire. During the three hours she had six runs over the measured mile, and the best run, with wind and tide, gave her a speed slightly exceeding 32 knots, but the mean of the three hours was 30.229 knots. She maintained an average indicated horse-power of 6189, which enabled her to keep up 400 revolutions. The air pressure in the cylinders was 3 in., the steam in the boilers 250 lbs., and the steam in the engine-room 233 lbs. The trial was in every respect satisfactory.

The Mallard.

The Mallard, torpedo-boat destroyer, went out from Chatham for a three hours' coal-consumption trial on September 7th. The results were satisfactory. The steam pressure in boilers was 211 lbs. per square inch, with an air pressure in stokeholds of 2.87 in., and the revolutions per minute were 398.1 starboard and 395.9 port. The engines developed 5749 horse-power, and the ship attained a mean speed on the three hours' continuous run of 30.201 knots, and a speed of 30.794 knots as a mean of six runs on the measured mile. The coal consumption was economical. The Mallard, which was built by Messrs. J. I. Thornycroft & Co., will now be prepared for her second series of trials.

[France.]

L'Amiral Pothnau.

This first-class armored cruiser attracted much attention at the naval review at Spithead. She is 360 feet long, 50 feet beam, 21 feet 4 inches average draught. Normal displacement, 5320 tons. The armament consists of two 7.4-inch guns in turrets, ten 5-inch guns in casemates and many of smaller calibre. In the 24 hours' trial, under natural draught, the engines developed 6845 horse-power, giving an average speed of 17.787 knots, the consumption of coal being 791 grammes per I. H. P. With forced draught 10,200 horse-power was developed and a speed of 19.2 knots. She has three funnels and two military masts.

D'Entrecasteaux.

Further details in the armament of the D'Entrecasteaux show that the eight 5-inch guns of the lower tier are each mounted in a separate armed redoubt. The guns are of 1893 model, 45 calibres, central pivot mounts. The ammunition hoists are worked either electrically or by hand. The guns can be trained by electricity as well as by hand. The arrangement of the battery gives a bow or stern fire of six 5-inch and one 9.4-inch guns, and a broadside fire of two 9.4-inch and six 5-inch guns. The turrets are worked by electricity, but can be turned by hand.—*Le Yacht.*

Dupetit-Thouars (C_3).

According to *Le Yacht* of August 28, orders have been received at Toulon for the construction of a new cruiser to be named Dupetit-

Thouars. She is to be a first-class armored cruiser to replace the Jeanne Bart type provided for by this year's budget. She is to cost about 20 million francs and is designed by M. Bertin. Her principal dimensions are: Length, 452 feet; beam at water-line, 63.6 feet; maximum beam, about 2 feet above water-line, 64 feet; draught, 23 feet; displacement, 9516 tons; speed at forced draught, 21 knots. Three vertical triple expansion engines, each connected to a screw, to develop 19,600 horse-power, steam being supplied by 20 Normand water tubular boilers. The normal capacity for coal and liquid fuel is 1020 tons, giving a radius of action of 6500 miles at 10 knots. This can be increased to 1600 tons carrying capacity, giving a radius of 10,300 miles at 10 knots. The armament will consist of two 7.6-inch guns, one forward, one aft, in turrets; eight 6-inch rapid-fire broadside guns, in armored casemates, so arranged that four can fire ahead and four astern. Four 3.9-inch rapid-firers on the superstructure, two firing ahead, two astern. The secondary battery consists of sixteen 47-mm. and six 37-mm. rapid-fire guns. There are two submerged torpedo tubes. Six search-lights will be provided. A sister ship, the Amiral de Gueydon, is to be laid down at Lorient.

[ITALY.]

VARESE.

The armored cruiser Varese was launched July 25 at Leghorn. Length, 328 feet; beam, 60 feet; draught, 24 feet; displacement, 6840 tons. Two triple expansion engines, supplied by 8 tubular boilers, are to develop 13,000 horse-power, giving a speed of 20 knots under forced draught. Coal capacity, 1000 tons, besides liquid fuel. The armament to consist of two 10-inch guns in two armored turrets of 6-inch thickness, one forward and one aft; ten 6-inch guns in armored casemates; six 4.7-inch guns on the upper deck, protected by shields; ten 37-mm. guns, two gatlings, and five submerged launching tubes. An all-around water-line armor belt of 6-inch nickel steel, above which the battery belt extends for 60 metres and protects the bases of the turrets, with thwartship end belts of same thickness. The protective deck varies in thickness from ¾ to 1½ inches.—*Le Yacht.*

[JAPAN.]

TAKASAGO.

This first-class cruiser was launched from the Armstrong works on May 29. She is a modified Yoshino type, length 360 feet, beam 46 feet, mean draught 23 feet, and of 4150 tons displacement. Protection is afforded by a steel protective deck running the full length of the ship, varying in thickness from 1.7 to 4 inches, and a conning tower of 3-inch steel. Two triple-expansion engines of 15,500 indicated horse-power are to give a speed of 24 knots. The armament to consist of two 7.8-inch, ten 4.7-inch, twelve 3-inch and six 47-mm. rapid-fire guns, besides five torpedo-launching tubes.—*Mittheilungen aus dem Gebiete des Seewesens.*

NEW CRUISER BUILDING AT SAN FRANCISCO.

This second-class protected cruiser, building at the Union Iron Works for the Japanese Government, is an enlarged and improved Yoshino. She will have a length at load water-line of 396 feet, extreme beam of

49 feet, and 17 feet 7 inches draught at normal displacement of 4760 tons. The twin triple-expansion engines are to develop 15,000 horse-power, giving a speed of 22½ knots per hour. Steam is supplied by four double-ended and four single-ended boilers. The normal coal supply is 350 tons; bunker capacity 1000 tons. Protection to the machinery is afforded by outboard coal bunkers and a protective deck 4½ inches thick on slopes and 1¾ on top, extending full length of ship.

The use of non-inflammable wood serves as protection against fire. The armament consists of two 8-inch and ten 4.7-inch R. F. rifles, twelve 12-pounders and six 2½-pounders. The 8-inch guns, one aft, one forward, are protected by steel shields and have each a train of 270°. They are expected to throw four aimed shots a minute. The 4.7-inch guns are mounted in 3-inch armored sponsons, with shield protection on the main deck, with 100° arc of train. The 12-pounder guns are mounted two forward, two aft, the rest on main deck in broadside. The guns are Armstrongs. There are five torpedo tubes. A sister ship is building at Cramp's yard.

In addition, the following vessels are under construction abroad: The battle-ship Shikishima of 15,000 tons, 14,500 horse-power, 18 knots speed, to be completed in two years by the Thames Iron Works; a second at Thomson works, and a third at the Vulcan works. A cruiser of 4350 tons, 15,500 horse-power, 22 knots, building at the Thomson works, is to be completed this year. Also six destroyers of 30 knots, two at Thornycroft's, four at Yarrow's; five torpedo-boats of 24 knots at Schichau and five at Normand's.

Speed Trials of Battle-ship Yashima.

The Yashima, one of the two first-class battle-ships now completing in this country for the Japanese Government, has just made her steam trials at the mouth of the Tyne. She has been built by Messrs. Sir W. G. Armstrong, Whitworth & Co., of Newcastle-on-Tyne, in two and a half years, from designs by Mr. Philip Watts, the director of Elswick Shipyard. The excellence of the design has been fully proved by the splendid results obtained on the trials, not only as regards speed and endurance, but also in respect of her manœuvring qualities, which were admitted by all who witnessed them to be very exceptional.

Speed trials were made on several occasions, the first official trials taking place on the 13th of July. It consisted of a four hours' run under forced draught with an air pressure in the stokeholds corresponding to a head of 1½ in. of water. For some time during this run a speed of 19.5 knots was maintained, and the mean speed for the whole four hours was 19.227 knots; the mean horse-power developed was rather over 14,000. A trial of six hours' duration was afterwards made with open stokeholds, when a power of nearly 10,000 horses was developed. The mean speed over this period was 17.26 knots, but the mean of four runs over the Admiralty measured mile during the early part of the run gave a speed of 17.76 knots, and this speed could have been maintained during the whole run if 't had been desired to do so. The mean speed obtained during the four hours' run with forced draught was nearly a knot in excess of the forced draught speed guaranteed by the contract; and even the mean speed obtained during the six hours' run with open stokeholds was half a knot in excess of the contract, whilst over the earlier part of the run it was a knot in excess of the contract.

The machinery worked with perfect smoothness and gave no trouble whatever, and the ship was practically free from vibration. It is needless to say that speeds one knot in excess of that promised in each case with forced and natural draught gave general satisfaction to the Japanese Commission, and the Japanese Government may be congratulated on possessing the fastest armored battle-ship afloat.

At the end of the natural draught trials, while the vessel was still at full speed, turning trials were made with the helm at various angles, and it was found that the vessel, with a length of over 400 feet over all, could turn in a circle of 180 yards in diameter, or less than one and a half times her own length, this was with the rudder hard over and both engines going ahead. This circle is, we believe, by far the smallest ever made by a vessel of this size, and is the result of having a large balanced rudder, carried low down beneath the stern, the dead-wood of which is very much cut away. This form has been adopted recently in all the Elswick cruisers, with such good results that it was determined to try it in the Yashima and in the Fuji.

The propelling machinery of the Yashima has been supplied by Messrs. Humphrys, Tennant & Co., of Deptford, and of the three-cylinder vertical triple-expansion type, the horse-power contemplated with forced draught being 14,000, and 10,000 with natural draught; and it is interesting to note that the trials were most successfully made after the engineers' strike had begun, Messrs. Humphrys thus losing the benefit of nearly all their best and most experienced hands, and being compelled to carry out the trials with a "scratch" crew. If it had not been for this, there can be no doubt that even better results would have been obtained.

Accounts of the principal features of the Yashima have already been published by us, but it will not be out of place to mention here that she is a vessel of 12,320 tons displacement, with a length of 372 feet between perpendiculars, beam 73 feet 6 inches, draught of water 26 feet 3 inches. She has a complete armored belt from 18 inches to 14 inches thick, and 14-inch barbettes, protecting two pairs of 12-inch guns, in addition to which she carries ten 6-inch quick-firing guns and numerous guns of smaller calibre.—*Engineer.*

[PORTUGAL.]

M. Croneau, French naval constructor, has undertaken the reorganization of the Portuguese dockyard. He is arranging for the building of a cruiser to be named the Rainha Amelia. She is to be 250 feet long, 36½ feet beam, and to have a displacement of 1660 tons. She is to be fitted with two triple-expansion engines of 3000 H. P., to give a speed of 16 knots natural draught, and with forced draught a speed of 17½ knots. Her armament to consist of four 6-inch, four 4-inch and two 47-mm. guns, all rapid-firers, two machine guns and two torpedo launching tubes.

[RUSSIA.]

THE TRIAL TRIP OF THE ROSSIJA.

On July 18th the first-class cruiser Rossija began her official full-powered trials on the measured mile. The port and starboard engines working together, were first tried, the trial lasting 6 hours. With these two engines, while steaming continually, ten trips each of four miles were made. The mean speed of the cruiser with an average of 83½ revolutions and a steam pressure of 21.8 pounds per centimetre was 19.74 knots. The greatest speed reached was 20.25 knots. The draught

of the ship during the trial was from 27.5 to 26 feet, with a displacement of 12,130. The four-bladed screws had a pitch of 8.4 metres and a diameter of 6.1 metres. The engines worked very satisfactorily, making five revolutions more than contracted for, viz., 80.

The trial of the middle engine, with a Bavis propeller of 4.6 metres pitch, lasted two hours. With this engine under full steam the cruiser made three trips, reaching a mean speed of 9.94 knots. The engine averaged 99.8 revolutions with a steam pressure of 21.8 pounds per square centimetre. The I. H. P. of the lateral engines, computed from 7 series of diagrams, was 15,697; that of the middle engine, the average of five series of diagrams, was 2749.7. The contract required 14,500 I. H. P. for the lateral engines and 2500 for the middle engine—*Marine Rundschau.*

[SPAIN.]

THE PELAYO.

The Pelayo is practically being rebuilt at the La Seyne works. In the first place the old boilers are being replaced by Niclausse boilers, with a saving of weight of 250 tons, which gain is to be devoted to strengthening the defensive strength of the ship. These alterations will take several months; they will consist notably in the construction of an armored redoubt, a cofferdam, and enlargement of the fresh-water system. Rapid-fire guns are to be substituted for the old battery, changes in the ammunition supply will be made, and the radius of action of the vessel will be generally enlarged.—*Le Yacht.*

[UNITED STATES.]

HOLLAND SUBMARINE BOAT PLUNGER.

The Holland torpedo-boat Plunger was successfully launched at the yard of the Columbian Iron Works, Baltimore, Md., on August 7. Her length is 85 feet and diameter 11.5 feet. Her displacement when floating light is 155 tons, and when down to her load water-line the displacement is 160 tons. Two sets of motive power are provided, one for the afloat and awash condition, and one for the submerged condition. Twin quadruple expansion engines, with steam furnished from a water-tube boiler, will operate twin screws when afloat or awash, and a 70-horse-power motor, fed from forty-eight chloride cells, will furnish the power when submerged. The steam power, electric dynamo and storage cells are so connected as to be readily reversible in their action, thus rendering it possible to recharge the cells from the dynamo, the steam engine being used as a prime motor. The electric power may also be connected to a propeller shaft placed in the axis of the boat, in addition to the connection with the main propeller shafts. The motor may thus operate a special propeller, in addition to driving the main shafts independently of the steam engines. The capacity of the storage cells is amply large to prevent injury or deterioration while giving off the power required to propel the vessel—a speed of about 8 knots for at least six hours. It is confidently predicted that the vessel will reach a speed of 16 knots in the light condition, while she will be able to reach 15 knots with three feet of water covering the hull, while not less than 8 knots while submerged will be acceptable. At these speeds an endurance of 15 hours awash and 10 hours submerged is anticipated. She will carry no guns or other armament except five automobile torpedoes, to be launched from two expulsion tubes. Two additional torpedoes can be carried, if desired.

BOOK NOTICE.

The marine number of Cassier's Magazine, published in August of this year, is a most interesting addition to marine and professional literature. The contributors are the highest authorities on the subjects dealt with, and their names are in themselves sufficient guarantee to commend this collection of valuable papers.

The contents are as follows: Specialties of warship design, by Sir William Henry White. Fast torpedo-boats, by A. F. Yarrow. The problem of steamship design, by Henry H. West. The launching of a ship, by Robert Caird. Hydraulic principles affecting a floating ship, by F. P. Purvis. Marine boiler furnaces, by D. B. Morison. Steamers for shallow waters, by John J. Thornycroft. The design and building of a steamship, by Archibald Denny. Water-tube boilers for war vessels, by Walter M. McFarland. The naval weakness of Great Britain, by Sir Charles W. Dilke. The modern marine engine, by Charles E. Hyde. American sound and river steamboats, by Leander N. Lovell. The auxiliary machinery of an American warship, by F. Merriam Wheeler. Shipbuilding and transportation on the great American lakes, by Joseph R. Oldham. Steel for marine engine forgings and shafting, by R. W. Davenport. The coaling of steamships, by S. Howard Smith. Submarine navigation, by John P. Holland.

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AUGUST 21. North Atlantic Squadron Manœuvres. Military Cycling. Japan's Ambition.

AUGUST 28. The Fortune of War. The Next Great War. The Greeks and the Turks.

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SEPTEMBER 18. The Havana Floating Dry Dock. The German Autumn Manœuvres. Our Dry Docks. Secrets of the Dockyards and Royal Ordnance Factories.

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JULY 3, 1897. The United States and Hawaii. Drill Regulations for the Navy (continued).

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SEPTEMBER 4. Auxiliary Cruisers. Drill Regulations for the Navy (continued).

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SEPTEMBER. The Future of American Shipbuilding. Electric Copper Refining in the United States. An Ocean Danger and its Remedy. Primary Technical Education in India. Electricity aboard Ship.

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JULY 10. The Boilers of H. M. S. Spanker. Working Sheet Aluminum. Boilers for Battle-ships Nos. 7, 8 and 9.

JULY 24. The Progress of Marine Engineering. Battle-ships of the Future. The Steam Navy of the United States.

AUGUST 7. A Novel Fire-box. High-speed Screw Propellers. Multiple-Expansion Engines and the Cost Account.

AUGUST 21. The Watson Radial Water-tube Boiler. Smokeless Powders and their Ballistic Results. Oil Fuel Burner. Evolution of the Marine Boiler. Reconstructed American Monitors. Submarine Vessels.

SEPTEMBER 4. Failure of an Upright Boiler. Fifty Years Advance in Marine Engineering. Possibilities of Liquid Air in Electrical Work. The Manufacture of Crucible Steel.

SEPTEMBER 18. Working Pressures of Marine Boilers. Structural Steel. Forced Draught. English and American Shipyards. Technical Education. Aluminum Brass and Aluminum Bronze. Explosive Properties of Acetylene.

THE IRON AGE.

JULY 1, 1897. The Armor Plate Contracts. The Future of the Torpedo. The Turbinia.

JULY 9. A Council of Ordnance. Signalling through Space without Wires. Making Big Guns for the Navy.

JULY 15. The Illinois Steel Company. Armor Plate $300 per ton.

JULY 22. British Naval Construction. Finishing the Breech Rings of Built-up Guns. The Armor Plate Question.

JULY 29. Some of the New Uses for Aluminum. A Large Steel Lake Schooner.

AUGUST 5. Electricity on the Steamship Bremen. Aluminum in Steel. The Future of Engineering in the Navy.

AUGUST 12. The Wellman Hoisting Magnets. Casting a Coast Defense Gun. The Wood Water-tube Boiler. Application of the Steam Turbine to Working of Dynamos. New Torpedo Tube for Japanese Battle-ship Fuji.

AUGUST 19. Renewing old Storage Batteries. The Largest Coast Defense Gun ever cast. The Armor Plate Matter.

AUGUST 26. A Course of Study in Electrical Engineering. Uniform American Boiler Specifications. The New Brown Wire-wound Gun.

SEPTEMBER 9. The Bement, Miles & Co. Projectile Lathes. A Steamer hauled by Rail. The Armor Plate Board.

SEPTEMBER 16. Our Merchant Marine. Power Transmission at Milwaukee Dry Dock Plant. A Record in Flanging Boiler Heads. The Chinese Iron Works. The Allis Cross Compound Vertical Blowing Engine. Some Properties of Metals. The Armor Plate Board.

SEPTEMBER 23. The Armor Plate Matter.

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JULY 24. Steerable Balloon. The Weapons for Modern War.

JULY 31. Submarine Photography. Latest Performances of the Turbinia.

AUGUST 14. Drill in the U. S. Navy.

AUGUST 28. Dry Dock No. 3, Brooklyn Navy Yard.

SEPTEMBER 4. The Umbrella Boat. Shrinkage of Castings. Steam Engine Condenser. Two New Range Finders.

SEPTEMBER 11. Boiler Tube Corrosion. Great Diving Bell. The Dangers of Fog. Repairing a Screw Propeller.

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JUNE, 1897. Scientific Work of the Boston Party on the Sixth Peary Expedition to Greenland.

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VOL. XXIX., NO. 2, 1897. Recent Foreign Surveys under the Direction of the U. S. Hydrographic Office. Notes on Some Dangerous Rocks off the Gulf of Darien.

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SEPTEMBER 9. A Notable Contract for Steel Work.

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JULY. The New United States First-class Cruiser Brooklyn, 9250 tons, 16,000 I. H. P. The Education and Training of Naval and Military Cadets. Two Operations in Woods, 1866 and 1870. The Proposed Naval College at Dartmouth. The Battle of Naseby.

AUGUST. Military Essay for the Gold Medal Competition. Army Signalling and its Use in War. Royal Marine Reserve.

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JULY, 1897. Coast Artillery Practice; how best to conduct it with regard to the requirements of actual warfare. The Choice Occupation and Change of Positions by Field Artillery. The German Method of bringing Guns into Action.

AUGUST. The Study of Military History as a means of Training for War. Accident to 12-inch B. L. Gun on Board the Russian Battle-ship Sisoi Veliki. Competitive Practice in the Garrison Artillery and its Effect on the Training of Officers and Men. Notes on Training Artillery Scouts.

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JULY 17. Gift of an Ironclad from the Cape.

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JULY 31. British Seamen, 1837-1897.—III.

AUGUST 7. Indian Mutiny in Fiction. Is the Battle-ship to become Extinct? British Seamen, 1837-1897.—IV. Cordite and the Rifle.

AUGUST 14. The Soldier of To-day. Naval Construction and Armament. British Seamen, 1837-1897.—V.

AUGUST 21. The Navy of the Future. British Seamen, 1837-1897.—VI. The Gun Accident on Board the Sisoi Veliki.

AUGUST 28. British Seamen, 1837-1897.—VII.

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SEPTEMBER 11. Armor-plate Trials. The Surgeon of Old in War. Floating Docks. The Limitations of Service Journalism. Our Home Defences. British Seamen, 1837-1897.—IX.

THE ENGINEER.

JUNE 11, 1897. Kearsarge Armor Test. The Naval Section of the Victorian Exhibition at the Crystal Palace. The Future of the Torpedo.

JUNE 16. Witkowitz Steel Plates. Naval Review at Spithead. Signalling through Space without Wires.

JUNE 25. Trial of Krupp Thin Armor Plates. The Review at Spithead. Naval Architecture at the Earl's Court Victorian Era Exhibition. H. M. S. Prince George.

JULY 2. The New System of Throwing High Explosives. Extra Hard Steel. The Naval Review of 1897.

JULY 9. The Institution of Naval Architects. The Progress of Marine Engineering in the Royal Navy and Mercantile Marine. Non-flammable Wood. Water-tube Boilers in High Speed Ocean Steamers.

JULY 16. Institution of Naval Architects. The Gangout. Aerial Torpedoes.

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JULY 30. Some New Features in Smokeless Powders and their Ballistic Results. How the Fleet at Spithead was Illuminated. Kirkaldy's Revolving Door for Water-tight Bulkheads. Fighting Powers of our Line-of-battle Ships.

AUGUST 6. British Armor Plates. Speed Trials of the Imperial Battle-ship Yashima.

AUGUST 13. Naval Engineers and Artificers. Experiments on the Nature of the Surface Resistance in Pipes and on Ships. Engineer Appointments.

AUGUST 20. Secrets in the Dockyards and Royal Ordnance Factories. Bullet-proof Clothing. Mean Pressure Indicator for High Rotational Speeds. A Portable Recorder for Tests of Metal.

AUGUST 27. Recent Armor Trials. France and her Navy.

SEPTEMBER 3. The Manchester Ship Canal. Shipbuilding and Marine Engineering on the Thames in the Victorian Era. The Argentine Training Ship Presidente Sarmiento. Floating Dry Dock for Cuba.

SEPTEMBER 10. Engines of the S. S. Empress Queen. Modern Japan. Recent Trials of Hadfield's Projectiles. Improved Lathe for Turning Projectiles.

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JUNE 11, 1897. Tolch's Reversible Propeller. The Battle-ship and the Torpedo Vessel. The Boilers of H. M. S. Spanker.

JUNE 18. Shipping and Naval Matters in Japan. Test for Marine Barometers. Signalling through Space without Wires.

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JULY 9. The International Congress of Naval Architects and Marine Engineers. Non-flammable Wood.

JULY 16. Crank and Propeller Shafts. High Speed Screw Propellers. Skin Resistance.

JULY 23. Kermode's Steam Steering Gear. The Mathematical Theory of Naval Architecture. On Dynamos.

JULY 30. Light-house Illumination in Japan. Armor Plate Press. High Explosives. The Navy Estimates. Hardened Plates and Broken Projectiles.

AUGUST 6. The Yashima.

AUGUST 13. Water-tube Boilers in High Speed Ocean Steamers. Forced Circulation Fuel Economiser. Hardened Plates and Broken Projectiles. High Speed Self-lubricating Steam Engines. The Mathematical Theory of Naval Architecture.

AUGUST 20. The Maxim-Schupphaus Smokeless Powder. The Mathematical Theory of Naval Architecture. A Portable Recorder for Tests of Metals.

AUGUST 27. Large Explosions and their Radii of Danger. The Maxim-Schupphaus Smokeless Powder and Aerial Torpedoes. The Mathematical Theory of Naval Architecture.

SEPTEMBER 3. Large Explosions and their Radii of Danger. Trials of Armor Plates. Coloring Steel. On Dynamos.

SEPTEMBER 10. Large Explosions and their Radii of Danger. Floating Dock for San Paulo de Loanda. Japan and Formosa. Deflection in Steamers. The Diffusion of Sulphide through Steel.

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tive Power of Warships. On Signs of Weakness in Tank Steamers. On Various Descriptions of Doors applicable to Water-tight Bulkheads, their Fastenings, etc. Use of Electricity on Board Ships. Recent Trials of the Cruisers Powerful and Terrible. Water-tube Boilers in Warships. A Mechanical Method of Ascertaining the Statical Stability of Ships. On the Fighting Value of certain of the older Ironclads if re-armed. The Application of the Compound Steam Turbine to the Purpose of Marine Propulsion. On the Use of the Water-line in Designing the Lines of Ships. The Accelerity Diagram of the Steam Engine. A Note on the Geometry of Stability. Acetylene Gas and its Probable Future Afloat. Nickel Steel as an Improved Material for Boiler Shell Plates, Forgings and other Purposes. Application of Electrical Transmission of Power in Marine Engineering and Shipbuilding.

THE STEAMSHIP.

JULY, 1897. The Boyle System of Ship Ventilation. Improved Materials and Shipbuilding Design. The New North German Lloyd Atlantic Steamer Kaiser Wilhelm der Grosse. Unusual Corrosion of Steel Vessels. The Future of the Torpedo.

AUGUST. Recent Improvements in Pumping Machinery for Marine Service. The Babcock and Wilcox Water-tube Marine Boiler. History and Progress of Marine Engineering. Non-flammable Wood.

SEPTEMBER. Mean Pressure Indicator for High Rotational Speeds. New Type of Self-trimming Steamer. Marine Boiler Explosions. An Efficient Steam Saver. High Speed Self-lubricating Steam Engines. Crank and other Shafts used in the Mercantile Marine. Designing a Steamship. Some Impressions of the Spithead Naval Review. Robey & Co.'s High Speed Engines. The Collapsible Boat Chock (Hamlyn's Patent). Propellers for Shallow-draught Steamers. The Dangers of Coal Cargoes. Fast Torpedo-boats. The Training of Engineers. Launch of Largest Steamer ever built at West Hartlepool.

MORSKOI SBORNIK.

MAY, 1897. Exploration in the Arctic Ocean. Future Naval Warfare. Comparative Strengths of the Fleets of the Three Naval Powers. Construction and Trials of Triple-screwed Cruisers. The Mounting of Search-lights on Ships.

JUNE. Discussion of Problems of Naval Tactics. Comparisons of American and British Ironclads. Steam Iceboat "Nadejnie." Notes on Metallurgy. Damage to the Steam Cylinder of the Torpedo-destroyer Star. Mishaps to Torpedo-boats Corrientes and Santa Fé. Discussion of Problems in Naval Tactics:

Organization of Fleets in the Future. Development of the Fleets of the Principal Naval Powers. Why it is disadvantageous for Russian Merchant Ships to navigate under the Russian Flag. Electro-motors. Present Status of the Theory of Ocean Currents. J. B. B.

RIVISTA MARITTIMA.

JUNE, 1897. Notes on the Proper Employment of Torpedo-boats. The Blechynden Boiler. The German Navy. The Maritime Laws of Ancona. Naval Armor:

This is an exhaustive article on armor tests of recent dates in Europe and America. The tests are tabulated and comparisons are made. An appendix investigates and compares the formulas for perforation adopted by different governments.

H. G. D.

ANNALES DU CONSERVATOIRE DES ARTS ET MÉTIERS.

2D SERIES, VOL. 8. Salubrity. Application of Electrolysis to Metallurgy. Life and Works of Olivier. Life and Works of La Gournerie. Researches upon the Instruments, Methods and Drawings of Topographical Work. A Projected Astronomical Observatory in Tunis. Bridge Building in America.

LE YACHT.

JUNE 5, 1897. Composition of Crews for Service in the Far East. The English 30-knot Destroyers. New Semaphore Signals.

JUNE 12. Comparison of Trial Trip Results. Gun and Armor with reference to Capped Projectiles.

The idea of using capped projectiles was first conceived by Admiral Makharoff of the Russian Navy. Trials at Ochta proved the increased facility in penetration with such projectiles. Experiments are being made in France in this direction. Two French firms, that of Saint Chamond and that of Unieux, are supplying projectiles capped on different systems. Saint Chamond use a light cap soldered to the ogive. Unieux secure the cap by slight projecting lugs on the ogive. In both of these systems, like that of Johnson, the aim is to merely secure the cap sufficiently so as to adhere to the point of the projectile after firing and until impact on the plate.

There are various theories advanced to account for the effect of the cap in increasing penetration. One of the French theories is that the cap first acting upon the hardened surface of the plate, slightly depresses it or cuts into the thin hardened face, so that the point of the projectile remains intact after it has passed the hardened face, permitting it to act more efficiently upon the softer non-hardened part of the plate.

Germany's Naval Strategy.

JUNE 19. The French Fleet compared with the Fleets of the Triple Alliance. The Naval Review at Spithead.

JUNE 26. The Naval Review at Spithead. The Report of M. Mahy on the Naval Credits.

JULY 3. After the Review at Spithead. New English Vedette Launch. French Naval Manœuvres in 1897. The Cruiser Pothnau.

JULY 10. The U. S. Battle-ships Wisconsin, Illinois and Alabama. Submarine Navigation.

JULY 17. The French Naval Manœuvres.

JULY 24. The English Naval Manœuvres. The French Manœuvres.

JULY 31. England's Sea Power. The French and English Naval Manœuvres.

AUGUST 7. The English Admiralty and New Naval Constructions. Perforated Sails.

The captain of the Italian ship Macdiarmid reports upon experiments made with the perforated sails of Vassallo system and increased speed obtained by their use. The Macdiarmid made the voyage from Cardiff to the Cape of Good Hope in 46 days, overhauling and passing more than 30 vessels bound the same way. From the Cape to Newcastle, Australia, took her only 35 days.

The Naval Manœuvres. The Turbinia's Engines.

AUGUST 14. The New English Navy Credits. The French Naval Manœuvres. The Parasol Boat. The Danish Cruiser Heimdal.

AUGUST 21. England's Naval Strength. The Squadron of the North at St. Malo. The Large English Cruisers, Diadem Type.

AUGUST 28. The Accident to the Bruix. New Site for French Trial Trips.

SEPTEMBER 4. Admiral Colomb on the Future of the Torpedo. The Injeniero Hyatt. The Sissoi-Veliky.

H. G. D.

LE MONITEUR DE LA FLOTTE.

JULY 17, 1897. The Grand Manœuvres. The Naval Budget. English Naval Manœuvres.

JULY 24. Towards the Poles. The Navy in Parliament. The Naval Manœuvres.

JULY 31 AND AUGUST 7. The Naval Manœuvres. Incombustible Wood.

AUGUST 14. The Seigle Boiler. The Yena.

AUGUST 21. Apropos of the Grand Manœuvres. The Accident to the Bruix.

AUGUST 28. M. Faure in Russia. The Accident to the Bruix.

REVUE DU CERCLE MILITAIRE.

JUNE 12. The Military Lessons of the Chinese-Japanese War.

JUNE 19. England's Naval Strength in the Indian Ocean. General Champion de Nansouty.

JUNE 26. Reorganization of the Italian Army. Entrance of German Naval Cadets.

JULY 3. Urgent Infantry Reforms. Reorganization of the Italian Army.

JULY 10. The German Army in 1897. Urgent Infantry Reforms (continued). Sautter-Harlé Dynamos for Torpedo-boats.

JULY 17. The Old and the New Russian Infantry Regulations. Scientific Branches and Schools of Instruction of the Spanish Navy. Urgent Infantry Reforms (continued).

JULY 24 AND 31. The Madagascar Expedition of 1895. Urgent Infantry Reforms (continued). Admission to the French War College. England's Naval Supremacy.

AUGUST 7. The Madagascar Expedition of 1895. The Alpine Manœuvres.

AUGUST 14 AND 21. The Alpine Manœuvres (continued). Urgent Infantry Reforms (continued). The Russian Grand Manœuvres. Italy's Experiment in Mobilizing the Fleet.

AUGUST 28-SEPTEMBER 4. The Madagascar Expedition of 1895 (continued). Urgent Infantry Reforms (continued). Reorganization of the Italian Army.

REVUE MARITIME.

MAY, 1897. Boiler Feeds. Aerial Currents, their Direction and Utilization by Aerostats. The Oceanographers of France. Value of Ships-of-War from an Artillerist's Point of View. Rambowed Cruisers in England. Tests of Dürr Boilers. Naphtha Fuel in the Russian Navy. Various Devices for Lessening Dangers of Collision.

JUNE. Boiler Feeds (concluded). Statistics on Shipwrecks for 1894. Aerial Currents, their Direction and Utilization by Aerostats. The English Naval Budgets, 1897 to '98. The Prince George. Trials of the Turrets of the English Battle-ship Caesar. The Brown Segmental Gun. Victory of Projectile over Armor. Test of Experimental Turret in the United States. Promotions in the Italian Navy.

JULY. Statistics on Shipwrecks for 1894. Vice-Admiral Magon. Aerial Currents, etc. Preparation for Naval War. The Pelorus. The Military Value of Old English Armor-clads with New Batteries. The German Naval Budget, 1897-98.

AUGUST. Statistics on Shipwrecks for 1894. Vice-Admiral Magon (concluded). Aerial Currents, etc. (concluded). Naval Policy. Germany's Naval Policy and Strategy. Trials of the Powerful and Terrible. H. G. D.

BULLETIN DE L'ASSOCIATION TECHNIQUE MARITIME NO. 7. SESSION DE 1896.

Theory of Pitching in a Seaway.
The Effect upon Stability of a Liquid Cargo.
Changes in Immersion, Stability and Trim experienced by a Vessel Floating on Liquids of Different Density.
Calculation of the Pressure Moment on Rudders.
Conversion of a Compound Engine designed for a Pressure of 71 lbs. into a Compound Engine for 171 lbs.
Naval Warfare.
Development of Navies during the Past Ten Years.
Shallow Draft Vessels with Screws in Funnels.
Derelicts.
Nautical Terminology.
Evaporators.
The Niclause Boiler.
The New Belleville Boilers.
Certain Special Steels. R. P. H.

MARINE RUNDSCHAU.

JULY, 1897. The History of the Fleet (continued). The Line-of-Battle Ships of the Century (with sketches). The New Rules of the Road at Sea. English Plans to open up Hudson Bay. Report of the Commanding Officer of the Möwe on the Attack by Natives of Aly Island upon a Surveying Party. French Fisheries on the Coast of Algiers and Tunis. Naval Notes.

AUGUST. The History of the Fleet (continued). Retrospect of the Past Services performed by the Warships Freya, Luise and Nautilus. Reports from Imperial Ships.

Report of the commanding officer of the Brandenburg upon the bursting of a steam pipe. Report of commanding officer of the Kaiserin Augusta on coaling ship in the Mediterranean: "In Malta the coaling was done by the coal firm's force, being handled in baskets holding about 88 pounds each; 716 tons were taken on board in 5½ hours. The firm guarantees its ability, with its own force, to deliver 1000 tons on board in six hours, or 2000 tons in a day. At Crete, coaling from a steamer alongside, with the ship's company, 410 tons of coal were taken on board in 10 hours, or an average of 41 tons per hour. On April 8, in the same harbor, 471 tons were taken on board in 9 hours, and on May 13, at Phaleron, 508 tons in 8 hours, averaging 64 tons an hour. This means that every man engaged had to handle over 200 cwt., transporting it about three meters in height and 50 meters of length."

Report of the commanding officer of the Bussard on the use of retarders on board the steamer Tavinni.

Tests of Belleville Boilers. Contributions on Nautical Astronomy. Pictures from the History of the Hansa. Naval Notes.

SEPTEMBER. The History of the Fleet, Supplement to the Line-of-Battle Ships of the Century. The Hydrographic Office of the British Admiralty. Reports from Imperial Ships.

Report of the commanding officer of the Möwe of the punishment of the natives of Aly Island.

Trial Trips of the Aegir. Finding Positions by Means of the Marc St. Hilaire Method, with especial Reference to Sources of Error. Naval Notes. H. G. D.

MITTHEILUNGEN AUS DEM GEBIETE DES SEEWESENS.

VOL. XXV., No. 7. The French Naval Manœuvres of 1896. Dip Observations in Order to Determine the Refraction Coefficient. Construction and Efficiency of Boilers. The English Battle-ships of the Majestic and St. George Class. Niclaus Boilers on the Spanish Cruiser Cristobol Colon. Foreign Naval Notes.

No. 8. The Battle of Lissa, 1811.

Gives a full description of the battle, its results, and review of preliminaries.

The Influence of Winds and Atmospheric Pressure upon the Tides. The Seychelles. Steam Trials with Temple-Guyot Water-tube Boilers. On a Formula for Reduction of Circummeridian Altitudes. Compound Steam Turbines applied to Boat Propulsion. Foreign Naval Notes.

No. 9. Alternating and Direct Currents. Italy's Fleet Manœuvres. Telegraphy without Wires, Marconi System. Disabling of Ships by Gun-fire. Foreign Naval Notes.

H. G. D.

DEUTSCHE HEERESZEITUNG.

No. 51, JUNE 26, 1897. Firing Development and Fire Discipline for Infantry.

Nos. 53 AND 54. Regulations for Manœuvres of Russian Infantry. The Fighting Tactics of the French Infantry.

Nos. 55 AND 56. Japan's Naval Construction Programme, 1896 to 1906. The Initiative in the German Grand Manœuvres. English and French Fleet Manœuvres.

Nos. 60 AND 61. A Fleet for Defense or Offense? Organization and Tactics of Mongolian Cavalry. Questions of Modern Artillery Combat.

Nos. 62 AND 63. Questions of Modern Artillery Combat. Launch of the O'Higgins.

Nos. 64 AND 65. Questions of Modern Artillery Combat. New English Warships.

No. 66. Questions on Artillery Tactics. Military Instructors for Corean Army.

No. 67. The Eclaireurs of the French Infantry. Questions of Modern Artillery Combats.

No. 68. New Russian Infantry Regulations. The Eclaireurs of the French Infantry. Questions of Modern Artillery Combats.

ANNALEN DER HYDROGRAPHIE UND MARITIMEN METEOROLOGIE.

No. VI., 1897. Description of two Hurricanes encountered on the Way from Singapore to Yokohama. Storm Signal System in Holland. Useful Tables to Compute Time of Star Occultations for 1898. New Cloud Pictures. Nautical Tables.

No. VII. Hydrographic Observations on the Route from Yokohama to Nagasaki. Sailing Directions for the Pacific Ocean, published by the German Observatory. Report of Magnetic Observations on German Coast, 1896. Possible Explanation of Mistpoeffern. The Ice Limits between Greenland, Iceland and Spitzbergen.

MILITÄR WOCHENBLATT.

No. 59, JULY 3, 1897. Infantry Tactics and Operations of Combined Weapons, 1896. French Marines at the Manœuvres.

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2. Each competitor to send his essay in a sealed envelope to the Secretary and Treasurer on or before January 1, 1898. The name of the writer shall not be given in this envelope, but instead thereof a motto. Accompanying the essay a separate sealed envelope will be sent to the Secretary and Treasurer, with the motto on the outside and writer's name and motto inside. This envelope is not to be opened until after the decision of the Board.

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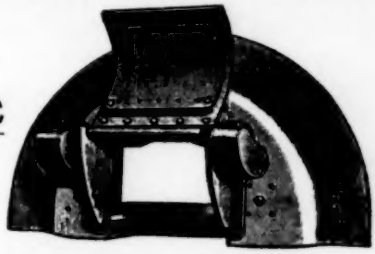

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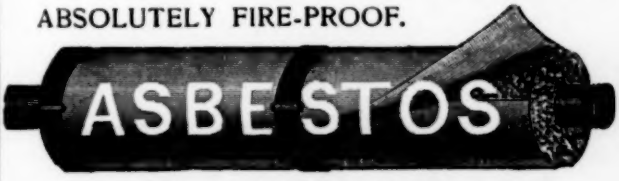

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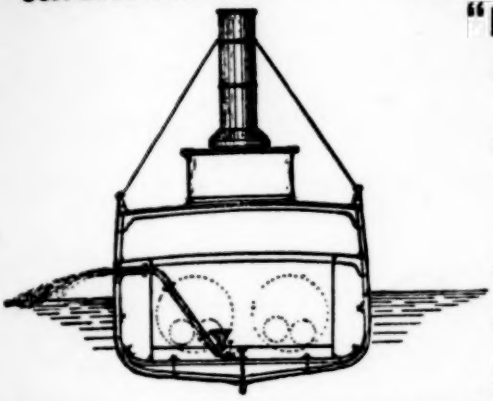

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